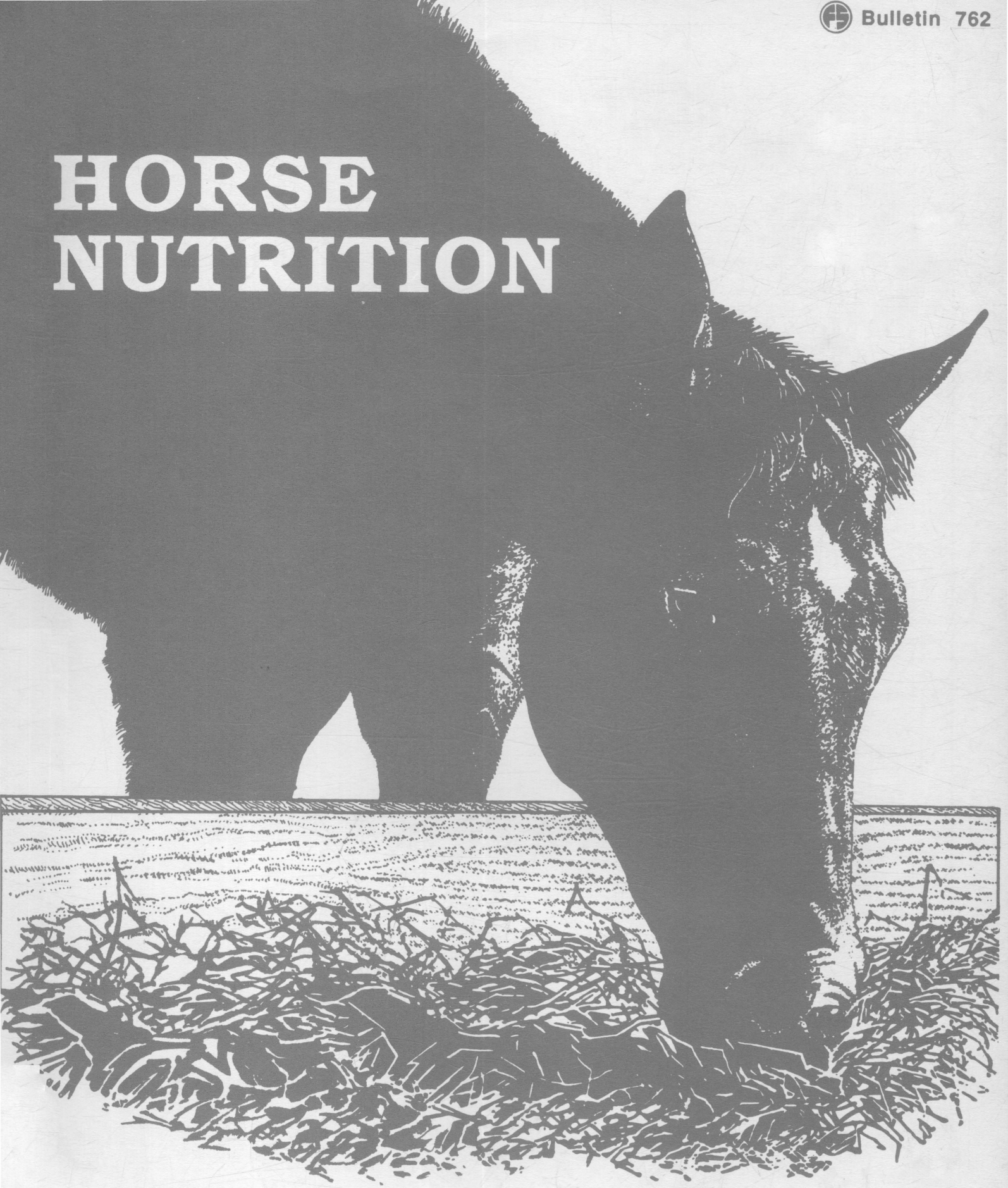
Bulletin 762

HORSE NUTRITION



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Horse Nutrition

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Part 1. The Horse's Digestive System

The horse is a nonruminant herbivore. This means the horse lives on vegetation and does not have a many compartment stomach such as a cow in which bacteria aid in the digestion of food. Instead the horse has a simple stomach that works much like that of a human.

Mouth

The mouth contains 36 (females) to 40 (males) teeth. These are important in harvesting forage and in chewing of the feed. Due to the design of the horse's jaws with the top jaw being wider than the lower jaw, horses often develop sharp points on the molar teeth. These may prevent normal chewing, which will reduce the food value received from the feed and may even predispose a horse to colic. The points may be removed by floating the teeth. Horses with a parrot mouth (overbite) or a monkey mouth (underbite) may also have difficulty in harvesting and chewing feeds.

Feeds are mixed with saliva in the mouth to make a moist bolus that can be easily swallowed. The saliva also contains an enzyme called amylase, but it is in very low concentration and probably of little use in digestion. Saliva is produced by three pairs of glands: the parotid, the submaxillary, and the sublingual. A horse will produce up to 10 gallons (85 lbs.) of saliva each day.

The pharynx, the soft palate, of the mouth is designed to prevent the re-entering of food into the mouth after swallowing. That is why food comes out of the nose in cases of choke.

Esophagus

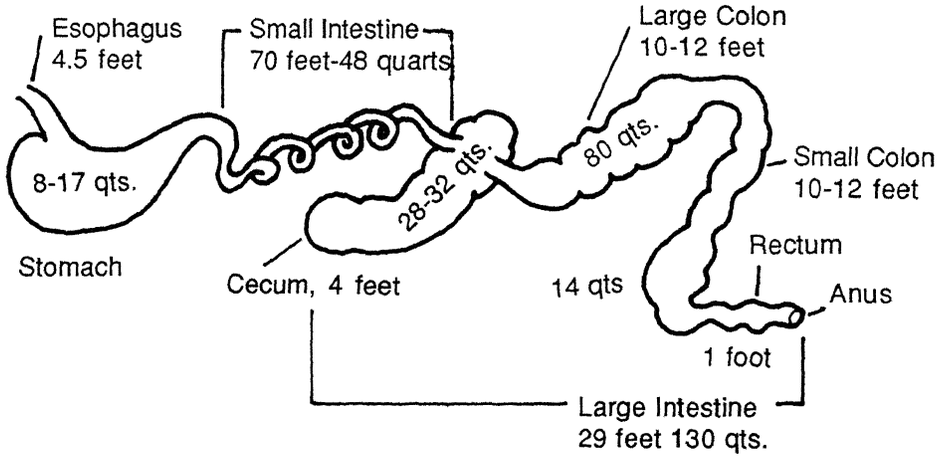
This is simply a muscular tube that takes the food from the mouth to the stomach. Because of the strong tonus of the muscle of the cardiac sphineter, the valve entering the stomach, it is almost impossible for a horse to vomit. The stomach will rupture instead of the horse being able to vomit.

Stomach

The stomach of the horse is small in relation to the size of the animal and makes up only 10 percent of the capacity of the digestive system. Originally, the natural feeding habits of the horse were to eat small amounts often. However with domestication, man began feeding meals to horses and has decreased the usefulness of the stomach. It has been established that we can improve the digestive efficiency of a horse by feeding small meals often, but this has to be weighed against the labor costs of doing it.

In the stomach, food is mixed with pepsin (an enzyme to digest proteins) and hydrochloric acid, which helps to breakdown solid particles. Also, there are some bacteria present that produce lactic acid. It is felt that these bacteria may be important in the case of a ruptured stomach. Ruptured stomachs occur most often in foals and often at the time of weaning. What probably happens is that a weaned foal stops eating at weaning due to mother being taken away. Then a few days later the foal decides to forget mother and go eat. Then the foal often overstuffs himself with grain high in carbohydrates. Lactic acid forming bacteria then ferment this mass of carbohydrate producing large levels of lactic acid, which cause paralysis of the pyloric sphincter, the stomach valve that normally let the food out and the stomach bursts from the gas produced in the bacterial fermentation of the feed.

The rate of passage of food through the stomach is highly variable depending on how the horse is fed. Passage time may be as short as 15 minutes when the horse is consuming a large meal. The stomach holds 8 to 16 quarts and begins to mix when it becomes a third full. If a horse is fasted for 24 hours, all food will be expelled from the stomach.



The Digestive System of the Horse

It has been a question for a long time as to what one should feed a horse first, grain or hay. Because of their density, grains tend to stay in the stomach longer, but it has not been proven to be advantageous to feed either first. It also has been a long standing question, if you should water a horse before or after a meal. If you leave it up to the horse, he will usually drink a little as he eats if consuming dry feeds. The best recommendation is to offer water free choice at all times.

Small Intestine

The small intestine of the horse is approximately 70 feet long and will contain up to 48 quarts. This is the major organ of digestion in the horse. Here, pancreatic enzymes are added that help digest the food: Carbohydrases that digest sugars and starches and Proteases that break proteins down into amino acids. Also, bile from the liver is added to emulsify (break into smaller units) fats and to suspend the fat in water. Bile constantly flows into the small intestine from the liver because the horse does not have a gall bladder to store it.

After the food has been digested it is absorbed through the walls of the small intestine and carried off by the blood stream to whatever cells that need the nutrients. Almost all amino acid absorption occurs in the small intestine. It takes only about 30 to 60 minutes for food to pass through the small intestine.

Horses are very susceptible to colic or death from toxic materials in the feed. Unlike the cow that has bacteria in the rumen that can detoxify materials before they reach the small intestine, the toxic material in the horse enters the intestine and is absorbed into the blood stream before it can be detoxified. Therefore, it is very important to not feed horses moldy or spoiled feeds. Urea is a feed supplement used by cattle that a cow can use in her rumen to make protein. This feed supplement can not be used by the horse because it is absorbed in the small intestine before it can get to the cecum where it could be used. Urea can be toxic to the horse, but the horse can tolerate the level at which it is added to cattle feeds. However, it is important to note that the horse can not use urea as a protein source and feeds with their protein level based on urea will not reflect an accurate protein level for the horse.

Cecum

The cecum is a blind sack that hold 40 quarts of food and fluid and is 4 feet long. The cecum is a microbial inoculation vat. The feeds that were not digested in the small intestine are attacked here by microbes that can break down the cellulose in the feed. Food will only spend about 7 hours here allowing bacteria time to start digesting the feed. The microbes will produce Vitamin K, the B Vitamins, proteins, and fatty acids. The vitamins and fatty acids will be absorbed, but little if any protein will be absorbed.

The cecum is odd in design because its entrance and exit are both at the top of the organ. This means that the feed enters at the top mixes and then is expelled back up at the top. This design is the cause of problems if an animal eats a lot of dry feeds without adequate water or if a rapid change of diet occurs. Both may cause a compaction in the lower end of the cecum, which in turn produces pain (colic). The microbial population in a cecum is somewhat specific as to what feedstuffs they can digest and if a change of feed occurs, it takes about three weeks to develop a microbial population that can digest a new feed and maintain a normal flow through the cecum.

Colon

The colon or large intestine will hold 80 quarts and is about 12 feet long. Food may reach here in a little as seven hours and will stay here for 48 to 65 hours. Microbial digestion continues here and actually most of the nutrients made by microbial digestion and their absorption occurs here. In addition to the vitamins and fatty acids absorbed in the colon, water is also absorbed resulting in fecal ball formation. These fecal balls, which are the undigested and mostly indigestible portion of what was fed, are then passed from the rectum.

Part 2: The Needed Nutrients

All higher forms of life require the six basic nutrients: water, protein, carbohydrates, fats, minerals, and vitamins.

Water

Water makes up about 70 percent of all mammalian bodies and has the following functions: (1) It is a carrier of substances that nourish, taking nutrients to the cells, and also transports wastes from the cells to the organs of excretion. (2) It helps to regulate body temperature. (3) It is involved in chemical and physical changes in digestion and metabolism (the assembling of nutrient units into living tissues or their use to produce energy for the body). (4) It is part of all body fluids; blood, saliva, synovial fluid (joint fluid), perilymph of the ear (for transmission of sound), and tears to wash the eye.

The quantity of water needed by the body is determined by many factors some of which include environmental humidity and temperature, dry feed versus green feed, lactation, and work. In general, a horse will drink .5 gallon of water per 100 pounds body weight in cool weather and may drink more than 1.5 gallons per 100 pounds if under excessive heat, work, and/or heavy lactation. With such a wide range in needs the rule for feeding water is to give free access to all the clean, fresh, not frozen water the horse wants. An exception to this rule is a horse that has been worked and is very hot. As long as a hot horse continues to work, it can drink its fill, but a hot horse should never drink its fill and cease working. The hot horse that has ceased work needs to cool out (30-90 minutes) before giving it all the water it wants. The hot horse can be given two or three swallows of water every 3 to 5 minutes while cooling out if you are walking the horse to aid in the cooling process. Some hot horses not following these recommendations have suffered from colic and/or laminitis (founder).

Deficiency problems

If water is deficient, the first thing that happens is the horse stops eating or decreases food intake. The most common reasons for deficiency are a dirty water container, lack of water supply, or frozen water. Horses without water are also likely candidates for colic. If a horse does not get sufficient water (most common in winter with dry hay and frozen water) the

feedstuffs can not be sufficiently mixed with water to allow normal passage through the gut and compaction colic results.

Another problem that may occur is that when you are away from home and offer the horse water that may smell and/or taste different than they are used to, they will refuse to drink. Although most horses would drink before they would die, they will become dehydrated and lack stamina. A way to handle this problem is to add a little brown sugar or other harmless tasty material to the water at home sometimes, and then when away from home the sugar will mask the taste of the different water. If the water smells bad a little vicks in the nose will mask the odor, however, as with the sugar, use it at home some so the horse is used to it.

Protein

Proteins are the building blocks of tissue and are composed of units called amino acids. There are about 22 different amino acids needed by the body, however, several can be made by the tissues of the body. There are 10 that must be supplied to the horse: threonine, valine, phenylalanine, arginine, lysine, leucine, methionine, isoleucine, tryptophan, and histidine. Lysine is the one most often lacking in growing horse rations.

The protein needs of the horse vary according to use and age. Table 5-3 gives the minimum level needed for various types of horses. From the table, one can readily see that protein needs are greatest for foals and for lactating mares. Work does not increase protein needs very much. For example, if we were feeding 15 pounds of a ration that is 10 percent protein to a mature horse and began riding the horse hard, we would maintain a 10 percent protein level but increase the total amount of feed used to maintain the horse in good flesh. This also would increase the total amount of protein given and be sufficient to meet extra protein needs caused by work.

Because of the high cost of protein, it is economically wasteful to feed more than is needed. Excess protein is broken down by the body to carbohydrates and urea. The carbohydrates are used for energy or changed to fat and stored, and the urea is passed in the urine.

In addition to cost another possible deterrent of excess protein is that it produces 3-6 times more body heat in breaking the proteins into energy as compared to using carbohydrates or fats for energy. This could be a problem for the endurance trail horse that has to keep as cool as possible as he works long and hard. Therefore, high protein rations are not recommended for these horses.

Occasionally, a horse will develop hives, commonly called protein bumps, on the skin. These can be an allergic reaction of the body to foreign proteins in the feed or more likely are the result of skin contact with some chemical in the bedding. Insect bites also cause these hives. Generally, the hives are short lived and no serious problem occurs.

High protein rations have also been blamed for the diseases of epiphysitis and contracted tendons. These problems are associated with fast growing foals, and fast growing foals are on high protein rations, which allow a foal to grow fast. However, it is the imbalance or deficiency of other factors such as minerals that are the real culprits, not the protein.

High protein rations have been reported to cause kidney damage in horses. This is an untrue old wives tale brought about because a horse on a high protein ration urinated more and the urine was stronger due to the excess urea being passed.

Energy

The main sources of energy are fats and carbohydrates. Carbohydrates in the ration are the sugars and starches of the grains and the cellulose (fiber) of the roughage and grain. Fats are the oils and related compounds in the grain and roughage and make up about 2 to 5 percent of the ration. A horse can handle a ration much higher in fat (as high as 40%) without digestive problems. Fats are necessary in the ration to produce healthy sleek haircoats. Many people add 1 to 2 ounces of cooking oil to the daily ration for the purpose of improving the haircoat.

Fats produce 2.25 times more energy per pound than carbohydrates and when used to produce energy, they produce the least amount of internal body heat. As a result some endurance horses are being fed as much as a pint of cooking oil each day when they are working.

The energy needs of a horse are measured in calories. The requirements are expressed as kilocalories (Kcal) or megacalories (Mcal = 1000 Kcal). Older nutrition manuals use the term Total Digestible Nutrients (TDN) to measure energy. One pound of TDN is roughly equal to 2000 Kcal of Digestible Energy (DE). Energy is used for maintenance, reproduction, work, growth, and lactation. Tables 5-1 and 5-2 give the energy needs for different activities and maintenance. To determine the total energy needs, you add the needs from the different sections of the tables that apply to your horse.

Excess carbohydrates or fats cause obesity in the horse, which is determental to any animal. The rule of thumb for a horse being in good flesh is that you can not see the ribs, but you can feel them if you rub your hands across them. Lack of sufficient energy in the diet is the primary cause of a thin horse, so give the horse more feed and increase the grain portion as it contains more energy per pound than roughage. Fat horses need less or no grain; good quality roughage can meet the needs of most idle mature horses.

Minerals

Minerals are necessary for most of the chemical reactions occurring in the body and also for the development and maintenance of the skeleton. Of the minerals, calcium and phosphorus, followed by sodium and chlorine (salt), are needed in greatest quantity by the body. Calcium and phosphorus makeup 70 percent of the mineral content of the body with 99 percent of the calcium and 80 percent of the phosphorus in the bones and teeth.

Calcium and phosphorus are needed in adequate amounts in the ration, but are also needed in the correct ratio. Table 5-4 lists the needed levels of calcium and phosphorus for various classes of horses. Too much of either one interferes with the use of the other. A ratio of 1.1-2.0 parts of calcium to 1.0 part phosphorus are ideal for the horse. A young, growing foal is most susceptible to an imbalance or deficiency and; therefore, their ration needs to be closely evaluated. Deficiency or imbalance may result in bone abnormalities, slow growth, contracted tendons, and/or epiphysitis.

Salt should be fed free choice to horses at all times. A mature horse doing light work will consume about 1 ounce of salt daily. However, salt intake varies between horses. As long as a horse has plenty of water available, salt toxicity should never be a problem.

Salt can be provided in block or loose form. The block form is handy to use and decreases waste, but it takes longer for horses to lick off what they need. Loose salt is easier to eat but is often wasted. In general, if a horse needs to consume a lot of salt such as an endurance horse, loose salt is recommended. Most idle horses and pleasure horses will easily meet their needs with block salt. It is recommended when feeding salt to always use trace mineralized salt. An exception to this may be the horse that is eating large amounts of salt as mineralized salt might produce a trace mineral toxicity.

Trace Minerals

Ohio is deficient in the trace minerals iodine and selenium and sometimes deficient in copper and zinc. See Table 5-6 for a list of the common trace minerals needed by the horse, its required level, and the amount usually present in feedstuffs. Most trace minerals are in adequate supply in the normal ration of the horse. However, in Ohio the soils and feedstuffs are often lower in the four minerals mentioned above than the table indicates.

Selenium is needed by the horse for normal muscle function and for normal function of the horse's immune system. This mineral is a problem because of its narrow range between the needed and the toxic level. Toxicity is characterized by loss of appetite, mane and tail hair, and, in the severe form, blindness, loss of hoof wall, paralysis and death.

Iodine deficiency or excess may result in goiter. Some pregnant mares on a seaweed vitamin supplement (high in iodine) have produced foals with goiter and open mares have had abnormal estrus cycles.

Copper is a marginally deficient mineral in Ohio. It has been identified as aiding in normal cartilage development, the normal change of cartilage to bone, tendon development, strength and elasticity of blood vessels, normal skin pigmentation, fertility, and to prevent anemia. Deficiency is associated with epiphysitis, contracted tendons, lower fertility in mares, rupture of the uterine artery of older mares during parturition, anemia, and depigmentation of the skin around the eyes and muzzle.

The copper level in feeds needs to be evaluated in regard to what other minerals are present in the ration because they may combine with the available copper and make it unavailable. Molybdenum, sulfur, and zinc have all been shown to "tie up" copper, making it unavailable to the horse. Possible sources of these three minerals are as follows: Zinc - galvanized pipes, water and feed buckets or white painted wood fences; Sulfur - from water with a high sulfur content (common in soils with underlying coal); Molybdenum - common in alfalfa hays (copper deficiency is likely if hay has less than four parts copper to each part molybdenum).

Copper at the level proposed in Table 5-6 is good for a horse but toxic to some other livestock, especially sheep. Therefore, highly copper fortified horse feeds should not be used indiscriminately for other livestock.

Zinc recently has been found to be low (less than 40 ppm) in some rations. It also can be toxic if it exceeds 200 ppm. Deficiency causes reduced growth rates and lesions of the skin on the lower extremities.

All of the trace minerals can be normally supplied by trace mineralized salt. However, if you are dealing with a deficiency in the ration, special high mineral salt may be needed to overcome the deficiency in the normal feedstuffs. There are also some high mineral feeds now on the market to help overcome ration deficiencies. High mineral broodmare feeds may be especially useful so that the mare may deposit sufficient trace minerals in the developing foal prior to birth. Because milk has a very low trace mineral content and because the foal can run short on trace minerals before it can eat enough other feeds that supply these minerals, the deposition in its body prior to birth becomes very important.

Two things that need to be remembered about adding trace minerals to a feed ration: (1) Because some trace minerals have a narrow range between needed level and toxic level, it is best to use commercially prepared preparations instead of trying to add them yourself, and (2) Table 5-6 lists the needed levels in the total ration. Therefore, if the hay portion is very low in a trace mineral, the grain portion must be high enough to produce the needed level for the whole ration.

Vitamins

A vitamin is an organic compound that is needed in small quantities to help run the many chemical reactions that occur in the body. They have been one of the most oversold feedstuffs to horsemen. A little is necessary, but a lot of vitamins can be harmful instead of more helpful. In truth under normal feeding programs with good quality feeds, horses do not need extra vitamins added to their ration.

Vitamin A - Beta carotene is common in green forages and the body easily changes beta carotene to vitamin A. Vitamin A is necessary for the health of the cells that line all tissues of the body; skin, respiratory system, eyes, reproductive organs, the alimentary canal, etc. Deficiency may result in poor haircoats, reproductive and respiratory tract infections, night blindness, and/or excessive tearing and diarrhea.

The horse can store excess vitamin A in the liver and is capable of storing enough to last 4 to 6 months. Forages made into hay contain vitamin A, but it dissipates quickly until after six months of storage, thay has very little vitamin A. However, by adding these two factors together, the horse can still meet its needs without adding the vitamin to the ration. The only exception would be horses fed poor quality hay or hay stored for more than six months, especially if the horse also received no green forage.

Vitamin A requirements are listed in Table 5-7. Exceeding the needs will be of no benefit and levels 10 times these will cause toxicity. Toxicity symptoms are frail bones, hyperostosis, and exfoliated epithelium.

Vitamin D - Vitamin D is called the sunshine vitamin because the ultraviolet rays of the sun will convert a compound (7-dehydrocholesterol) in the skin into vitamin D. Horses exposed to 4 to 6 hours of outdoor light (even on cloudy days) will make sufficient vitamin D. In addition, sun cured forages contain the vitamin. Perhaps if a horse is not exposed to the sun or good quality hay, a deficiency could occur. Table 5-7 gives the amount needed in the ration. However, levels 10 times that listed will be toxic, causing calcium deposition in soft tissues, which can damage muscle, blood vessels, kidneys, and the heart.

Vitamin K - This vitamin is highly supplied in all forages, green or dried. It is also produced by the microbes in the cecum and colon and absorbed there. Vitamin K is necessary for normal blood coagulation. A deficiency is recognized by failure of the blood to clot when a cut or injury occur.

Dicumerol a compound produced by a fungus on sweetclover

in the green or dried state can cause a deficiency of Vitamin K. However, sweetclover is rarely used to feed horses any more. Excess vitamin K has been shown to be toxic in some animals causing rupture of the red blood cells.

Vitamin E - Vitamin E deficiency has not been reported in the horse, and an ample supply is found in the normal feedstuffs of the horse. Vitamin E has been linked with selenium in normal muscle function, and it is often given in treating "tying up" syndrome. The vitamin also has been given to improve reproductive performance, but there is no evidence that this helps. The vitamin also has been used to increase the horse's immunity to infectious disease, but again no proof for this is known.

B Vitamins - This is a group of vitamins that are available in the normal feedstuffs and are made by the microbes of the cecum and colon. As a result only horses on low roughage diets and/or under severe stress are likely to become deficient. Deficiency results in poor appetite, sour attitude, and anemia. B vitamins have also been fed to horses to decrease nervousness, but there is no scientific evidence to support this. Vitamin B12 has commonly been sold to horsemen to improve the horse's performance, but it has been shown to not be needed by the horse.

If a horse is under a lot of stress such as a foal out in terrible weather or an endurance trail horse that is being worked very hard, it may be beneficial to add B vitamins to the ration. Brewers dried yeast is an excellent source and can be added to the ration at the rate of 5 pounds per ton of feed and meet the horse's needs. Injections are an acceptable way of giving B vitamins to a horse but are of no more benefit then adding them to the feed.

Vitamin C - This vitamin is not needed in the horse's diet because the horse can make sufficient amounts in its liver. Many claims for vitamin C have been made but none substantiated.

Part 3. Feedstuffs

Feedstuffs are generally placed in three classes; concentrates, roughages, and additives. How much of any of these different classes that are used is based on the size and activity of the horse you are feeding.

Concentrates

These are feeds that contain high levels of nutrients. The grains and protein supplements fall into this category.

Oats have been considered the number one grain for horses for many years. The characteristics that have earned this title are that the oat is bulky and thereby less likely to cause digestive problems, and higher in protein than corn. Although the oat is about 12 to 13 percent protein, the quality of the protein is not excellant and one should not be feeding oats alone to meet protein needs.

Oats may be fed whole, rolled, or crimped. Today the cost of rolling and crimping are not worth the extra nutritional value derived from doing so. If you are buying crimped oats, be sure that the seed coat is only slightly broken. If the oat is completely crushed, most of the nutrients may be lost and you will not get your money's worth.

Corn has taken over the position of the number one grain fed to horses in recent years mainly because of its low cost and excellent feed value for energy. If you want to fatten an animal, it is easier done with corn than oats and at a lower cost.

Corn can be fed on the cob as whole shelled or cracked corn. Actually, cracking corn is economically wasteful. Because of the size of the kernal of corn, a horse will chew the grain before swallowing. If a horse is passing a lot of whole kernals of corn in the feces, the horse is either bolting his feed or needs to have his teeth floated because sharp points are preventing normal chewing. The bolting horse needs to slow down his feed intake. To do this, large rocks can be placed in the feed pan with the feed. He then has to sort around the rocks to get the feed. Another cure is to spread the feed out in a large feed bunk so it takes him longer to pick up the grain.

Corn is about 10 percent protein, but as all grains the protein quality is poor because it is low in the amino acid lysine. Corn contains about double the energy that an equal volume of oats contains. This has been the cause of corn getting the repetition as being a "hot feed." When people substituted corn for oats at an equal volume, their horses would sweat more and/or get fat. To eliminate the problem corn needs to be fed at only half the volume or less. There also has been a claim among draft horse breeders that corn caused bog spavins in the hocks of draft horses. There is no basis to this claim, except that if you fed corn at a level to make the horse overweight and then worked him hard, you could be stressing the hock joint and thereby cause bogs. However, the cause was not corn, but overweight and stress.

Barley has been fed to horses with excellant results. It is about 11 to 13 percent protein and must be fed in a rolled or crushed form. The grain in its whole form is too small and hard for the horse to use efficiently and safely. The main reason for not using barley more today is cost of the grain.

Wheat bran, which is a byproduct of the milling industry, is often used as a horse feed. Bran contains about 17 percent protein, is considered a laxative feed, and is high in phosphorus. However, the protein is of low quality, the laxative effect does not exist, and the phosphorus content may upset the calcium-phosphorus balance in the feed ration. Also there is a question as to the availability of the phosphorus that is present in bran. Much of it is tied up in an indigestible form and, therefore, is not being used much today for horse feeds.

Molasses has been added to horse feeds to increase palatability and decrease dustiness. The palatability factor is questionable because horses learn to eat what they are trained to eat. If a horse is used to eating feed with molasses added, he often will refuse other feeds, and horses that have never eaten feed with molasses tend to not want to eat such feed. The major use of molassess is to bind fine particles to the grains so that a well mixed feed can be fed containing all the needed minerals, vitamins, protein, etc. without the fine particles settling out. Dry molasses is of no use because it only adds to the amount of fines, which are undesireable in horse feeds. Molasses is an energy source as a feed, but its cost makes it a poor choice economically as an energy source for horses.

Protein Supplements

Basically, these are the high protein parts of grains that have had the oil removed for use in other industries.

Soybean oil meal is the oil meal of highest biological value and has a 44 percent protein content on an as fed basis. The quality (biological value) of a protein supplement is based on a comparision of the amino acids that make up soybean protein to the amino acids required by the horse to make up his proteins. Not only do they need to have the same amino acids, but they should be present in the same relative percentages. Soybean oil meal is especially high in lysine, which commonly is low content in most grains. Soybean oil meal is also usually the cheapest source of protein available for horse feeds. Soybeans should not be fed to horses in their raw form. In the raw form they contain an inhibitor of protein digestion in the horse. Raw soybeans are especially detrimental in foal rations.

Linseed oil meal used to be in great demand as a protein supuplement in feed rations for horses. Linseed oil meal is high in sulphur containing amino acids, which were thought to aid quality of hair coat. Actually, the quality of haircoat came more from the oil in the meal. In addition, modern processing removes most of the oil thereby decreasing its value for horse feeding. Linseed oil meal is about 35 percent protein as fed, costs more and has a lower biological value than soybean oil meal. Linseed oil meal is a good source of selenium and is often recommended if a deficiency is expected.

Cottonseed oil meal contains about 39 percent protein on an as fed basis and is second to soybean oil meal in quality. If it is available and cost effective, it may be used for horses. Cottonseed oil meal contains a substance called gossypol, which interferes with digestion and is particularly undesireable for feeding foals. Adult horses can tolerate the gossypol. Recent research in other species has shown cottonseed oil meal to decrease sperm production in males, and this effect is thought to occur in stallions too.

Animal proteins such as meat scraps or blood meal are not acceptable in large amounts in most horse rations. If much is added to the rations horses will refuse to eat the feed. In addition animal byproducts are an excellant media for bacterial growth that could produce toxins to cause digestive problems.

Roughages

Roughages are generally grasses or legumes in either the green or dried state. In general it takes about three pounds of green forage to provide the same amount ot nutrients found in one pound of dried forages. Roughages for horses fall into those from the grass and legume families.

The grasses commonly used for horses are timothy, orchardgrass, bromegrass, tall fescue, and Kentucky bluegrass.Table 5-5 lists the nutrient values for these grasses in the green, immature state and also as they would be in hays. In general, grass hays (depending somewhat on time of harvest) are low in protein compared to legume hays. They are also low in calcium and phosphorus, but the ratio of these two minerals are in the correct ratio (2:1). Grass hays are usually easier to harvest than legume hays without becoming dusty and they are quite adequate nutritionally for most mature horses.

Of these grasses, fescue is the only one that has any serious problems as a horse feed. Fescue often has a fungus (endophyte) living in it that can cause agalactia (reduced milk production), low feed intake decreasing rate of gain of body weight, excessive salivation, and has also been blamed for extra thick placental membranes, which often cause death to the foal during birth. Fescue can be used safely by not giving it as the sole source of nutrition to pregnant mares and growing foals. If at least half of the ration is made up of other high quality roughage or concentrate, the effects of the fescue endophyte seem to be neutralized. Also there is now endophyte free fescue seed available, so if this seed is purchased for new seedings, it should eliminate the present problems with fescue.

Legumes commonly used for horses in Ohio are alfalfa, red clover, ladino clover, and birdsfoot treefoil. The nutritional values for alfalfa and red clover are listed in Table 5-5; the values for the other two are very similar to red clover.

The legumes are generally higher in protein (depending on time of harvest) than the grass hays. They are also higher in minerals but have an incorrect ratio (often 5:1) of calcium to phosphorus. As a result of the high protein, they are very desireable in the ration of growing animals, but the calcium-phosphorus ratio must be balanced to prevent bone abnormalities.The legume hays are more difficult to make due to leaf shatter which can produce dusty hay and/or stemy less digestible hay. With modern hay making techniques and recognition of the nutritional value of legume hays, these hays, especially alfalfa, have come to be the hay of choice for horsemen.

Red clover may have a fungus that grows on it that will cause the horse to salivate escessively. This fungus is most common in clover raised under wet conditions. It is not recommended to feed horses red clover hay if it is causing this excessive slobbering. If the horse is taken off the clover hay and fed other hay for a few days the slobbering will stop without special treatment.

All hay after it is first baled will go through a curing process where the microbes that are on the hay will cause fermentation due to the moisture that was left in the hay. Hay should not be fed during the curing process for about 3 to 4 weeks after baling because its nutrient content changes rapidly from day to day and is likely to cause colic.

Silage

Legumes or grasses may be made into silage or haylage. However, these are not recommended to be fed to horses due to the mold content of these feeds. There have been several cases of horses killed by being fed silage.

Additives

Vitamins

As stated in the section on needed nutrients, most horses do not need vitamins added to their rations. However, if the feedstuffs are of low quality or the horse is under stress, vitamins may be added as follows: (1) For vitamins A,D,E,K, add 5 pounds of a vitamin premix per ton of mixed feed. If you are using a commericial feed, it probably already has the vitamins added for you. A cattle or swine premix for these vitamins will work as good as a horse premix that probably contains the same vitamins but costs more. If B vitamins are desired, add 5 pounds of Brewers Dried Yeast per ton of feed. Table 5-7 lists the vitamins and the horse's daily requirements.

Minerals

The trace minerals and salt may be added as trace mineralized salt. This can be added to the feed at the rate of 20 pounds per ton of feed and should be offered free choice. Again, commerical feeds probably already have salt added. Table 5)5 lists several calcium and/or phosphorus sources used to balance these minerals in the feed.

Part 4. Feeding Horses

Idle Mature Stallions, Geldings, Mares

Mature horses that are not being used for hard work or reproduction can live very well on grass or a good quality grass hay without grain. If they are worked, then extra energy is required and can most easily be supplied by adding a concentrate.

Broodmares

It has been found that mares in good flesh or in a gaining condition at breeding conceive the quickest. Also, if a mare is ready to foal and you want to have the best success getting her in foal again, she should be slightly fat at foaling time. The reason for this is that lactation for her foal is a large drain on her system and if she is a little fat at foaling she is better able to handle the stress of lactation and to start the next foal inside her. Mares, unlike cows, do not have difficulty giving birth if they are fat.

Protein levels for mares at various stages of pregnancy and lactation are listed in Table 5-3.

During gestation, the mare does not actually develop much foal mass until the last three months of pregnancy. Therefore, she can be fed as a mature idle horse if not being riden or fed to meet what is needed because of work until that time. The pregnant mare can be rode or used to work as a nonpregnant animal until the seventh month of pregnancy, the work load for the seventh to ninth months should not include jumping, hard gallops or other excessive stress, and during the last two months, she should receive exercise that is limited to walking.

After foaling the mare needs a large increase in energy, protein, and minerals in the ration to provide for lactation. Most mares can meet these needs if turned out on a good quality pasture. It is wise to offer trace mineralized salt and Dicalcium Phosphate free choice to the mare at all times. If the grass is not good, grain may be added to the ration. However, if a mare needs grain to maintain lactation, it is probably time to wean the foal as it is cheaper to feed the grain to the foal than to run it through the mare to make milk. Usually, mares will start to lose weight in July and August when the pastures are not producing enough, and the foal is needing a lot more nutrition than the mare can supply. So the foal is weaned then at about four months of age. Foals may stay on the mare to six months if it is not determental to the health of the mare.

At weaning time the mare is separated from the foal and put on a ration for a mature idle horse unless she is thin and needs grain to get back in good flesh. Her udder will enlarge and become firm and tender to the touch. It is the pressure of the milk in the udder that will cause milk production to cease, so milking the mare to relieve the pressure only slows the process. It takes at least 30 days for the udder to stop producing milk. So, do not put the mare back with her foal for at least that long, and it is not recommended to put foals with mature horses if it is not necessary.

Stallions

Most horsemen overestimate the protein needs of the breeding stallion during the breeding season. In truth, energy is the nutrient that needs to be increased most for the breeding stalion and not protein as some think. Actually there is not more than 2 to 3 pounds of protein in all the sperm that a stallion will produce in one breeding season. See Table 5-1 for the energy needs of the breeding stallion. In addition to nutrition, it is also wise to have the stallion in good physical condition as he enters the breeding season.

Foals

Lactation in the mare peaks in two months after foaling and by four months will only provide about 50 percent of the energy and protein and about 30 percent of the calcium and phosphorus needed by the foal. Therefore, creep feeding (providing feed where the mare can not eat it) needs to begin early in the foals life.

Creep feeding begins as early as one week of age. Foals learn to eat grain quicker if they eat with their mothers first. You can also help start them by putting some grain in their mouths. Be sure the creep feeder is near to where the mare likes to loaf so the foal will be encouraged to enter the creep and eat. The creep feed should be at least 16 percent protein, of high quality and very palatable. Pelleted feeds work best for creep feeds because they do not spoil as quick and insure all of the nutrients are eaten as compared to feeds with molasses that mold and the fines containing the minerals and protein can still settle out and be left by the foals.

The foal will probably only eat about a pound of feed a day during the first month but will gradually increase to as much as 10 pounds a day by weaning time. At weaning, be careful that the foal does not overeat. Also be sure that there is always good clean feed available in the creep feeder. There have been cases of foals overeating after weaning or when creep feeders were refilled after being empty for some time. The result of overeating may be colic or a ruptured stomach. If the foal is getting too fat on free choice creep, you may want to limit the amount fed each day. Usually by one year of age, foals are all taken off free choice feed.

Orphan Foals

If at all possible, get at least two pints of colostrum (the milk secreted by the mare for the first 24 hours after foaling) into the foal within the first 18 hours. This milk contains antibodies to protect the foal from disease until his own system can produce antibodies. You can use colostrum from another mare if it is available. If no colostrum is available, you need the veternarian to develop an antibotic and vaccination program to help protect the foal.

There are milk replacers available for horses, but they are often hard to find on the spur of the moment. Therefore, to feed the foal until one can be found, you can use a calf milk replacer as long as it contains iron. Do not use veal calf milk replacer. If you are not able to get a calf milk replacer, you can mix one teaspoon of karo syrup to four ounces of skim milk to use until a replacer can be found.

You do not need to feed the foal out of a bottle, and you do not need to warm the milk. To start the foal drinking, stick your fingers into the mouth and he will begin to suck. Then, as the foal sucks, lower his head into a pail of milk until he is drinking. If you have a hard time getting the foal to suck rub him briskly, which will often start the sucking instinct. Once the foal is drinking the milk, put the pail in a location in the stall where the foal has easy access. It helps to use a bucket with bright

contrasting color to the stall wall to help the foal find it. Change the milk twice a day, providing about the amount the foal will drink between changes. At the same time, place a second bucket beside the milk bucket and place a very palatable pellet of at least 18 percent protein in it. Place a few pellets of the feed in the foals mouth each day until he starts to eat on his own. Also, limit the foal to 5 gallons of milk per day to encourage him to eat the pellets. Fresh water should also be available in the stall and a flake of high quality hay should be available.

The first solids a foal will eat is the mother's manure. It is thought that this is important to innoculate the gut of the foal with the micro-organisms that are necessary for normal digestion. Because the orphan foal does not have a mother and to prevent diarrhea, which usually occurs about day 9 of foal's life, add a little sheep manure in the bucket with the high quality pellets for about two weeks. This provides the micro-organisms without also providing the parasites that are in mare's manure.

Within one month the foal will usually wean itself from the milk. Continue the pellets free choice and supply high quality hay free choice.

Yearlings

Yearlings are still growing and therefore need more protein than mature horses. Table 5-3 gives the required protein level. Most yearlings will require high quality roughage and some grain to meet their needs. Often, yearlings look pot bellied. If this is the case. they are either wormy, or the quality of their feed is not sufficient to meet their needs without stuffing themselves. The cure is to worm if needed or supply a better quality feed so they get the needed nutrients without distending the digestive system with a large volume of feed.

Special Feeding Problems

Horses with emphysema (Heaves) are a special problem due to their allergic response to dust. These horses are best kept out of doors because enclossed barns contain too many dust particles in the air. Their feeds need to be watered down to keep any dust from being inhaled. For heavey horses, there are some complete pelleted feeds available that eliminate dust.

Occassionally, old horses can not chew their feed as well due to their teeth being worn to the gums or even missing. These horses may need to have their feeds ground or again the complete pelleted feed may be useful. Also, they may have impaired ability to digest the feed and will need higher quality feed than normal.

Complete pelleted rations for normal healthy horses can be used, but horses often become severe wood chewers as a result. The reason is simply that they can eat the pellets quickly and are then bored for something to do. They also do not feel full. Due to the concentration of nutrients in pellets all the nutritional needs can be met with a small volume of feed, leaving the horse feeling still hungry.

Part 5. Balancing Feed Rations

There have been several methods devised to develop feed rations for horses. Most methods are based upon a trial and error basis making substitutions until all factors balance in the ration. Many people do not care to make their own ration but will buy commerical mixes. These mixes made by respectable feed manufacturers are very good. If you are feeding only a few horses or do not want the hassle of always having to check the nutrient levels of your feed, commercial mixes are a good way to met the needs of the horse. However, you need to know what commerical mix to buy to match the feeds that you may be feeding.The following general rules will help the horse owner to either mix his own feed or help the one who buys commercial feeds to make wise decisions as to which feed to buy and how much to feed:

1. Foals less than 6 months of age eat 2 to 4 percent of their live weight in dry feed per day. Older horses eat about 1.5 to 2 percent of their live weight in dry feed per day.
2. It takes about 3 pounds of green grass to equal 1 pound of dried grass. Horses on pasture often eat 60 to 100 pounds of grass each day in order to get enough dry matter to provide the needed nutrients. That is where the term "grass belly" came from because horses have to destend their belly so much to get sufficient feed into their system.
3. A feed ratioin should be at least 50 percent roughage (hay or grass) to ensure proper digestive tract function. If a ration needs to contain a higher percent concentrate (grains) than 50 percent, some bulky grains such as oats should be used in the grain portion. In general, the portion of the ration that would be as grain to meet the horse's needs would be as follows: 0-10% for mature, idle horses; 50-70% for weanlings; 50% for yearlings; 30% for two year olds in light training; and 20-70% for horses at work.
4. When mixing a ration if you feel that a vitamin deficiency may exist because of the quality of the feed or the stress of the animals, an ADE vitamin premix for either swine or cattle can be added to the mix at the rate of 5 pounds per ton of feed. If you are raising foals, you may want to also add 10 pounds of Brewers dried yeast per ton of creep ration to provide B vitamins. Table 5-7 lists the vitamin requirements for horses. Caution, do not overfeed vitamins.
5. Grains are high in phosphorus, low in calcium. Legume hays are high in calcium, low in phosphorus. Grass hays are correct in the ratio of calcium to phosphorus but are too low for each for horses under two years of age and pregnant or lactating mares. Most commercial rations are balanced at a calcium to phosphorus ratio of 1:1. Therefore, if you are feeding a pure alfalfa hay, you may have an incorrect mineral ratio and need to supplement the diet with more phosphorus. Table 5-5 lists minerals commonly used to balance the calcium/phosphorus ratio.
6. Trace mineralized salt should be added to all grain rations at the rate of 1 percent per ton of feed.
7. If minerals and salt are to be added to the concentrate, liquid molassaes will need to be added to bind the fine particles to the grains, or the concentrate will need to be pelleted. If molasses is added it should not exceed 7 percent to prevent clumping in cold weather if the concentrate is to be augered out of a bin. Most commericial grain mixes contain 5-10% molasses.
8. Use your eyes to feed horses. If the horse is getting thin, add more feed or increase the concentrate portion of the diet. If it is getting fat, decrease total feed or decrease the concentrate portion of the ration. You should not be able to see a horse's ribs but feel them when rubbing your hand across them.
9. If you feed a highly concentrated ration (all the needed

nutrients in a small volume) such as a complete pelleted ration, horses are more likely to chew on wood out of boredom or to get more fill for their digestive tract.

10. Most rations are best when kept simple. Adding a lot of different grains and various supplements does not necessarily improve a ration and often may make it economically wasteful or even dangerous.

11. Energy needs are best met by grains and protein needs are met by legume hays or protein supplements.

12. Remember, a ration is the total feed intake of a horse for one day and includes both the concentrate and roughage portions.

In general, when you approach making a ration, you start by providing adequate protein because it is the most expensive ingredient. Then, you check if that ration supplies adequate energy and, if not, you begin to adjust proportions of nutrients and/or substitute nutrients to try to end up meeting both engery and protein needs. Then, minerals are usually checked last because they can be added without affecting energy or protein very much. Table 5-5 lists the nutrient levels of many of the common nutrients used for horses. Table 5-1 lists the engery requirements for mature horses. Table 5-2 lists the energy requiremants for growing horses. Table 5-3 lists the percent crude protein that a ration needs to contain for various classes of horses. Table 5-4 lists the calcium and phosphorus requirements for various classes of horses. These tables will be used in balancing rations for various horses using some of the different methods used to balance rations.

Ration Balancing Examples

Approximate Method

Example

Feed a 1100-pound, (mature wt.) two-year-old at moderate work (two hours of jogging, which includes two race miles 45 minutes apart).

Step 1. Determine the nutrient requirement.

A. Total feed intake - this should be between 1.5-2.0% of body weight. We will use 20 lbs (picked at random within the range 16-22 lbs.) total feed intake as an estimate to start.

B. Crude protein (CP) - Table 3. indicates that the ration should be 10% if the horse's ration is at least 1.5% of body weight, which it is. 20 lbs. X 10% = 2.0 lbs of CP required.

C. Digestible energy (DE) - Using Tables 1 and 2 the requirement is 16.5 + 12.54 (from work section of Table 1: .57 X 11 X 2) = 29.04 Mcal of DE.

Step 2. Because the horse is working, we can guess that the ration will require about 50% concentrate to meet the energy needs. The other 50% of the ration will be roughage. Start by feeding 10 lbs. of hay and determining what nutrients it will supply. We will use an alfalfa-orchardgrass hay that is a 50-50 mix of grass and legume.

$$10 \text{ lbs hay X } \frac{16.0\% + 10.1\%}{2} = \text{lbs CP}$$

(The 16.0 + 10.1 is the CP of alfalfa and orchardgrass from table 5. They are added together and divided by 2 because the hay is half alfalfa and half orchardgrass.)

10 lbs hay X 13% (rounded off) = 1.3 lbs CP

$$10 \text{ lbs hay X } \frac{1.04 + .94}{2} = \text{Mcal of DE}$$

(The 1.04 + .94 is the DE of alfalfa and orchardgrass,(from Table 5) again divided by two because the hay is equal parts alfalfa and grass.

10 lbs X .99 = 9.9 Mcal of DE

Step 3. What does the rest of the ration need to provide?

DE = 29.04 required
− 9.90 supplied by hay
19.14 Mcal of DE required in concentrate

The grain of highest Mcal level is corn at 1.75 Mcal/lb. Therefore it will take 11 lbs of grain to meet the energy needs in stead of the 10 lbs we were originally going to use.

11 lbs corn X 1.75 = 19.24 Mcal

CP = new adjusted total needed in ration because we had to add more grain to meet energy needs.

21 lbs of feed X 10% CP =
2.1 lbs CP required
−1.3 lbs CP in the hay
.8 lbs needed in the grain ration

$$\frac{.8 \text{ lbs}}{11.0 \text{ lbs}} = 7.2\%$$

This means our grain must be at least 7.2% protein. All grains exceed this so no protein supplements are needed.

11 lbs corn X 10.9% CP = 1.2 lbs CP

The total ration contains 1.2 lbs CP (grain) + 1.3 lbs CP (hay) = 2.5 lbs CP. The only way to decrease the protein to get down to the 2.1 level required would be to use a poorer quality hay. The +.4 lbs is not enough to be concerned about. Actually having some excess CP is good as we are relying on a lot of the CP to come from the grain, and we know that the protein quality of grain is less than ideal. Thus, the excess can help make up for the decreased quality.

Therefore, the ration is:

	DE	CP
10 lbs hay	9.90	1.3
11 lbs corn	19.24	1.2
21 lbs	29.14 Mcal	2.5 lbs

Step 4. Check calcium (Ca) and phosphorus (P) ratio and levels (Tables 4 and 5)

Ca: Corn = .05% X 11 lbs = .0055 lbs
Hay = (Alf) 1.5% + (O.G.) .35%, averaged = .925%
.925% X 10 lbs = .0925 lbs
Total Ca = .0980 lbs
.0980/21 lbs = .476% of ration as Ca
P: corn = .60% X 11 lbs = .066 lbs P
Hay = (Alf) .25% + (O.G.) .31% averaged = .28% P
10 lbs X .28% = .028 lbs P
Total P = .094 lbs
.094/21 lbs = .44% P in total ration

Ca and P are in balance (1.07:1) in the ration and are in sufficient quantity (.45% Ca and .35% P required from Table 4). For added protection, dicalcium phosphate should be provided free

choice along with trace mineralized salt.

Step 5. Because all nutrients and needs are based on moisture free values, the ration needs to be corrected to an as fed basis. Use Table 5 to do the following:

$$\frac{10 \text{ lbs of hay X } 100}{.89 \text{ (\% moisture in hay)}} = 11.2 \text{ lbs hay}$$

$$\frac{11 \text{ lbs of corn X } 100}{.88 \text{ (\% moisture in corn)}} = 12.5 \text{ lbs corn}$$

Total ration as fed would be 23.7 lbs

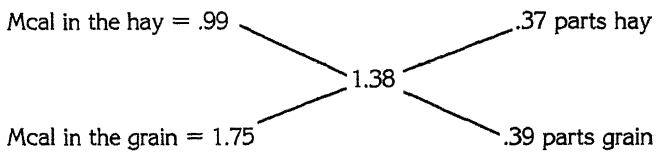
Pearson Square

This is another trial and error method to balance feed rations. Using the same feeding problem as before the procedure would be as follows:

Step 1: Determine the nutrient needs. From the last problem - 10% CP, 29.04 Mcal, and 21 lbs of feed.

Step 2: Divide the total Mcal/lbs of ration = the Mcal level required in the ration. 29.04/21 = 1.38 Mcal/lb We already know the CP level is .10 (10%).

Step 3: Set up and solve the Pearson Square.

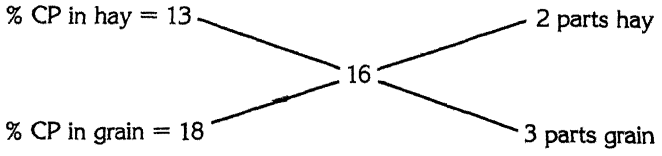


To set the square up you place the desired level of Mcal needed in the ration in the center. The Mcal level per pound of hay and grain are then placed as shown and you substract across the square. This produces the proportions of each of the parts of the ration (the hay and the grain) that need to be fed to meet the energy requirement. To complete the calculations, divide .37 by .76 (total number of parts) = 48.7% of ration should be hay. Then take 48.7% X 21 (lbs of total ration) = 10.2 lbs of hay. Then divide .39 by .76 = 51.3% of ration should be grain. Then multiply 51.3% X 21 = 10.8 lbs of grain.

Next you go through the same method using CP. Because the CP of corn is 10.9% and the CP of the hay is 13%, and we want a 10% level in the ration, the square is useless because both ingredients exceed the needed level in the feed.

Again as in the previous example the feed needs to also be checked for calcium and phosphorus level and balance. The feed also needs to be converted to an as fed basis as previously done.

The Pearson Square is very useful to help determine the protein level of the commerical grain mix you wish to purchase and how much of the grain mix to feed with your hay. For example: You are feeding weaninglings with a 13% CP hay and you need to buy grain mix that will produce a 16% CP ration. Set up the Pearson square as follows:



First we know that whatever grain ration is purchased, it will have to exceed 16% CP as the hay is only 13%. Therefore, select whatever feed mix is available that exceeds 16% (used 18% in problem). From the calculation we can see that it will take 2 parts of hay for every 3 parts of grain fed to balance the ration. If we wanted to feed less grain and more hay to provide more roughage we would have to buy a higher CP grain mix.

Simultaneous Equation Method

If you are an algegra buff you may want to try this method. The advantage to the system is that it produces a balanced formula for CP and DE in a one time through method. The disadvantage of the method beside the difficulty of the math is that it may produce answers that are not desireable. For example it may tell you to feed 2 pounds of hay and 18 pounds of grain, which could be dangerous even though it balances mathematically. In such a case you may need to change the feeds used to produce a more desireable ration.

Example: Feed a weanling (6mos.) that will mature to 1320 pounds using corn, soybean oil meal (SBOM), hay (50/50 orchardgrass-alfalfa late bloom), and molasses (added to bind SBOM and minerals to the grain).

Step 1: Needs =

16.9 Mcal (Table 2)

16% CP (Table 3)

11.5 lbs total ration (A foal at this age should weigh about 500 lbs X 2.3%)

We will feed about 5% of grain mixture as molasses and grain should be about 50% of the ration. Therefore 5% X 6 (rounded up from 5.75) = .3 pounds, which supplies .44 Mcal. The CP that molasses would contribute is so small and of such poor quality that it is not even counted.

Adjusted needs

16.46 Mcal (molasses substracted)

16.43% CP(the %CP needed in 11.2 lbs to have 16%CP in 11.5 lbs when the molasses is added = 11.5 X 16/11.2)

11.2 lbs total ration (molasses substracted)

$$\frac{16.46 \text{ Mcal}}{11.2} = 1.4696 \text{ Mcal/lb}$$

Step 2: Set up equations for 100 lbs of feed

X = hay, Y = corn, and Z = SBOM

Equation A: X + Y + Z = 100

Equation B: .97X + 1.75Y + 1.63Z = 146.96 (these are the Mcal value per pound for each feed and the total Mcal in 100 lbs)

Equation C: .125X + .109Y + .509Z = 16.43 (these are the CP levels per pound for each feed and the total lbs of protein in 100 lbs)

Step 3: Solve the equations

Equation B	.97X + 1.75Y + 1.63Z = 146.96
Equation A X .97 =	.97X + .97Y + . 97Z = 97.0
Substract to make equation D	.78Y + .66Z = 49.96
Equation C	.125X + .109Y + .509Z = 16.43
Equation A X .125	.125X + .125Y + .125Z = 12.5
Substract to make equation E	− .016Y + .384Z = 3.93
Equation D X .384	.2995Y + .2534Z = 19.18
Equatiin E X .66	−.0105Y + .2534Z = 2.59
Subtract	.3100Y = 16.59
	Y = 53.52

Using equation D	.78(53.6) + .66Z = 49.96
	41.8 + .66Z = 49.96
	.66Z = 49.96 - 41.8
	.66Z = 8.16
	Z = 12.36
Using Equation A	X + 53.52 + 12.36 = 100
	X = 34.12

Step 4: Change X,Y,Z to lbs fed per day, check minerals and determine feed on an as fed basis.

	lbs	DE(Mcal)	CP(lbs)	Ca(lbs)	P(lbs)	lbs as fed
Hay	3.8	3.686	.475	.03116	.01026	4.26
corn	6.0	10.500	.654	.00300	.03600	6.82
SBOM	1.4	2.283	.713	.00434	.00980	1.55
Molasses	.3	.440	.000	.00315	.00045	.40
	11.5	16.909	1.842	.04165	.05651	13.03

Calcium = .04165 lbs/11.5 lbs = .36% (Need .70% from Table 4)
.0070 X 11.5 = .0805 lbs total required minus .04165 from above ration leaves .03885 lbs to add to balance ration.
Phosphorus = .05651 lbs/11.5 lbs = .49% (Need .50% from Table 5).
.0050 X 11.5 = .0575 lbs total required minus .05651 from above ration leaves .0014 lbs to add to balance ration.
If add .1 pound Ground Limestone and .03 pound Dicalcium Phosphate you add .0432 lbs Ca and .0056 lbs P. This balances the minerals for level and they are in a ratio of 1.3:1, which is acceptable.

Step 5: Mix 1 ton of the concentrate for this ration. To solve find the percent each ingredient is of the total concentrate using the as fed weights as feed is bought on that basis. Total concentrate weight is 6.82 + 1.55 + .4 + .1 + .03 = 8.9 lbs. Corn = 6.82 lbs / 8.9 = 76.6% X 2000 lbs = 1533 lbs, SBOM = 1.55 lbs / 8.9 = 17.4% X 2000 lbs = 348.3 lbs, Molasses = .4 lbs / 8.9 = 4.5% X 2000 lbs = 89.9 lbs, Ground Limestone = .1 lbs / 8.9 = 1.1% X 2000 lbs = 22.5 lbs, Dical = .03 lbs / 8.9 = .33% X 2000 = 6.7 lbs Due to rounding off the total = 2000.4 lbs.

Table 5-1. Digestible Energy Requirements for Horses

Maintenance

Mature weight	Mcal required
440 lbs	8.2
880 lbs	13.9
1100 lbs	16.4
1320 lbs	18.8

Maintenance Mcal needed _____

If horse is not mature (24 mos. or less) get DE requirement from Table 5-2 instead of using maintenance value. _____

Work

Light work (slow trot, pleasure riding, little cantering)
.23 Mcal X _____ cwt. of horse X _____ hrs. work = _____

Moderate work (canter, sweating, fast trotting)
.57 Mcal X _____ cwt. of horse X _____ hrs. work = _____

Heavy work (galloping, jumping, heavy sweating)
1.77 Mcal X _____ cwt. of horse X _____ hrs. work = _____

Pregnancy (last 90 days)
Add two Mcal

Lactation (first 4 months)

Mare's weight (lbs) =	Mcal required =
440	6.4
880	9.5
1100	12.0
1320	14.3

Lactation requirement _____

Breeding Stallion (only during breeding season)
.57 Mcal X _____ cwt. of horse = _____

Total DE requirement is the sum of all of the above items that apply to the horse being fed. _____

Table 5-2. Digestible Energy Requirements of Growing Horses (Mcal)

Age (months)	Mature Weight 440	880	1100	1320
3	7.4	11.5	13.7	15.1
6	8.8	13.0	15.6	16.9
12	8.2	13.8	16.8	18.9
18	8.1	14.4	17.0	19.1
24	8.1	13.9	16.5	19.3

Table 5-3. Minimum Crude Protein Requirement (% in Ration)

	% In Ration	% of live Wt. fed/da
Mature idle horse	8.5	1.5
Pregnancy (last 90 days)	11.0	1.5
Lactation (first 4 mos.)	14.0	2.0
Foals (creep feed, nursing)	18.0	2.8
Weanlings	16.0	2.3
Yearlings (12 mos.)	13.5	1.9
Yearlings (18 mos.)	11.5	1.7
Two year old	10.0	1.5

* % of live weight fed is based on moisture free feed. Actual % of weight eaten will be higher on an as fed basis. Also if the horse eats more of less th percent of their weight per day in moisture free feed the percent protein needs to be adjusted accordingly.

Table 5-4. Calcium-Phosphorus Requirement for Horses As Percent of Ration

	Calcium %	Phosphorus %
Mature maintenance	.30	.20
Mares last 90 days pregnancy	.50	.35
Lactating mares (first 4 mos.)	.50	.35
Foal (creep feed first 6 mos.)	.85*	.60*
Weanling	.70	.50
Yearling (12 mos.)	.55	.40
Yearling (18 mos.)	.45	.35
Two year old	.45	.35
Mature horses all levels of work	.30	.20

* These levels may be too low for foals being fed for maximum growth. The values should be Ca = 1.0% and P = .80% for foals being fed all they can eat.

Table 5-5. Nutrient Content of Common Feedstuffs (Moisture Free)

Feed	% Dry Matter	DE Mcal/lb	CP%	Calcium %	Phosphorus %
Corn	88	1.75	10.9	.05	.60
oats	89	1.51	13.6	.07	.37
Barley	89	1.64	13.9	.05	.37
Wheat bran	89	1.33	17.0	.12	1.43
Soybean oil meal	90	1.63	50.9	.31	.70
Linseed oil meal	91	1.38	38.9	.43	.90
Molasses	75	1.48	4.3	1.05	.15
Alfalfa Hay					
Early bloom	90	1.10	17.2	1.75	.26
Mid bloom	89	1.04	16.0	1.50	.25
Full bloom	89	.98	15.0	1.29	.24
Dehydrated alfalfa meal 15%	91	1.10	16.3	1.40	.24
Red clover hay	89	.98	14.9	1.49	.25
Timothy hay					
Pre bloom	88	1.06	12.0	.50	.25
Late bloom	88	.90	9.0	.41	.19
Orchardgrass					
Fresh (immature)	19	1.10	18.4	.57	.54
Hay	88	.94	10.1	.35	.31
Fescue					
Fresh (immature)	27	1.04	11.5	.60	.43
Hay	88	.91	10.5	.57	.37
Bluegrass					
Fresh (immature)	31	1.11	17.0	.56	.40
Hay	90	1.00	11.0	.30	.29
Ground Limestone	—	—	—	36.10	—
Dicalcium Phosphate	—	—	23.70	18.80	
Monodicalcium Phosphate	—	—	—	16.80	22.10
Monosodium Phosphate	—	—	—	—	25.80

Table 5-6 Trace Mineral levels Required, Toxic Levels, and Levels Found in Feedstuffs

Mineral	Needed level	Toxic level	Normal range found in feed	
			Roughages	Grain
Potassium %	.4		1.5-2.5	.3-.5
Magnesium %	.09		.15-.6	.1-.2
Sulfur %	.15		.15-.5	.15-.4
Iron (PPM)	50		150-400	30-90
Zinc (PPM)	40-60	200	17-22	17-50
Manganese (PPM)	40		25-190	6-45
Copper (PPM)	20-30		5-25	4-9
Cobalt (PPM)	.1			
Selenium (PPM)	.1	5.0		
Iodine (PPM)	.1	4.8		

Table 5-7. Vitamin Requirements for Horses

Vitamin	Mature Horses	Growing Horses
A*	1140 IU/100 lbs	1800 IU/100 lbs
D	300 IU/100 lbs	300 IU/100 lbs
E	700 mg/100 lbs	700 mg/100 lbs
Thiamin	140 mg/100 lbs	140 mg/100 lbs
Riboflavin	100 mg/100 lbs	100 mg/100 lbs
Pantothenic Acid	700 mg/100 lbs	700 mg/100 lbs

* Pregnant and lactating mares require 2300 IU/100 lbs

The following rations have been developed and balanced. In addition to the nutrients listed vitamins may be added if you feel they are needed. It is also recommended to have free choice Trace Mineralized Salt and Dicalcium Phosphate available.

	Crude Protein				
	10%	12%	12%	14%	14%
Corn	50.0	50.0	82.0	51.0	26.0
Oats	42.0	35.0	—	27.0	53.0
Soybean Oil Meal	—	6.5	11.0	14.0	13.0
Molasses	5.0	7.0	5.0	5.0	5.0
Ground Limestone	1.0	1.0	1.25	1.0	1.0
Dicalcium Phosphate	1.0	—	1.0	1.0	1.0
TM Salt	1.0	.5	0.75	1.0	1.0

	Crude Protein				
	16%	16%	16%	18%	18%
Corn	50.0	23.0	67.0	23.0	53.0
Oats	18.0	48.0	—	44.0	12.0
Soybean Oil Meal	24.0	21.0	23.0	25.0	27.0
Molasses	5.0	5.0	6.75	5.0	5.0
Ground Limestone	1.0	1.0	1.25	1.0	1.0
Dicalcium Phosphate	1.0	1.0	1.0	1.0	1.0
TM Salt	1.0	1.0	1.0	1.0	1.0

Part 6. Pasture and Hay for Horses

Pastures and horses are a logical combination from the standpoint of providing both exercise and feed for the horse. However, many horsemen are uninformed when determining what plant species should be in a pasture and how to manage it for maximum feed production. In Ohio, it takes from one to five acres of pasture to provide enough feed for the summer. Under expert management, a horse can gain sufficient summer feed on one and a half acres. To have more than one horse for one and one half acres of pasture changes the pasture to simply an exercise lot, or at best only a partial supplier of feed. It will take an additional one to two acres to produce hay for winter feed based on supplying two tons of hay per horse.

Pasture Management

Many pastures that are presently unproductive can be improved with a little management. There are several methods that may apply to improving pastures.

Weed Control

Weeds can be controlled by either clipping or herbicide application. Clipping pastures should be done at least once a year and better if two or three clippings a year. Clipping should be done when weeds are flowering and before seeds are developed. Clipping desireable plants will also improve their nutritional value because young plants are more digestible than mature forage. (Caution - When clipping and dragging pastures, you will also be spreading the manure piles. If this is done in warm moist weather, you will be infecting the pasture with parasites; therefore, clipping and dragging should be done in hot dry weather to kill the parasites.)

Herbicides can also be used to control weeds. Banvel (1/2 to 1 pint/A), 2,4-D amine or ester (1 to 4 pt./A) or a combination of the two can be used without removing the horses from the pasture. These herbicides are effective against bull thistle, Canadian thistle, chicory, plantain, burdock, dandelion and will help reduce iron weed infestation. These herbicides also will kill any legumes (i.e. clovers, alfalfa) that are present in the pasture. Herbicides should be applied during rapid plant growth such as is common in the spring or in the early fall after rains.

Soil Fertility

Grasses need a soil environment that is 6.0-7.0 pH and the nutrients, nitrogen (N), phosphorus (P), and potash (K). Legumes need a soil environment that is 6.5-7.0 pH and the nutrients, phosphorus and potash. Legumes do not need nitrogen because they are capable of making their own by absorbing it out of the air into nodules located on their roots. Many times with just adequate fertilization and good grazing practices, the good pasture plants can increase in number and make the pasture more productive.

In general, the soil should contain 40 to 60 units of P and 220 to 260 units K. It takes about 10 units of P_2O_5 (P source in commercial fertilizer) to raise the soil 1 unit, and it takes 2.5 units of K_2O (K source in commercial fertilizer) to raise the soil 1 unit. After the soil is brought up to these levels, then annual application would be as follows: (A) If the pasture is at least 30 percent legumes, add 40 pounds per acre P_2O_5, and 80 to 100 pounds per acre of K_2O. (B) If the pasture is less than 30 percent legume, then nitrogen also needs to be added in addition to P and K as given above. The amount of nitrogen will vary based on amount of forage you wish to produce. Eighty pounds per acre will give production of less than two tons of dry matter per acre and 120 pounds will give more than two tons per acre. In general, each 50 units of Nitrogen will give an additional 1000 pounds of dry matter and increase the crude protein value of the grass 2 units. However, there are limits to adding nitrogen because excessive nitrogen will actually burn or kill the vege-

tation if too much is applied at one time or a lot is applied in dry weather. Therefore, it is recommended that nitrogen be applied in split applications the first being in late march or early april and the second in late August when fall rains are beginning.

When applying fertilizer, animals do not need to be removed when applying the granular form. Just be careful not to have any spills of fertilizer where a horse could eat enough of the material to be toxic to him. When applying liquid fertilizer, animals should be removed until rains come and wash the fertilizer off the plants.

To determine the fertility level of soil, take soil samples and have them analyzed. The local county extension office or local fertilizer companies provide this service. There is a small charge to have the soil analyzed.

Rotational Grazing

This method involves dividing the total pasture area available into smaller pastures. Then, livestock are moved from one pasture to another, which gives the grazed pasture time to reestablish the plant root reserves. Ideally, plants should be given a 30-day rest to rebuild after being grazed. Continual close grazing causes plant death. For maximum production, move animals when the plants have been grazed to a height of 2 to 2 1/2 inches.

Renovation

Some pastures reach the point that one needs to start over or the owner wishes to establish a more productive pasture by using different plant species. In general, renovation is done by one of the following methods: (A) Plowing and preparing a new, firm seedbed free of weeds. (B) Surface tilling, which is disking up the surface to kill the present vegetation. To do this, the surface needs to be disked, time allowed for the plants to die and then, additional diskings until all plants have died. (C) No-till, which involves using herbicides to kill the present vegetation and then using a no-till drill to plant seeds in the soil under the dead vegetation.

The herbicides used are as follows: Use 2,4-D at the rate of one pound of active ingredient per acre for broadleaf weed control, followed 10 to 14 days later with Gramoxone Super at the rate of one and one half pints per acre to kill remaining plants. The new seeding may be made just prior to or immediately after the Gramoxone Super treatment. With either of these methods, it is recommended that one make new seedings in mid April to early May or in August. It is also recommended that the soil fertility be corrected prior to renovation. Animals must be removed from new seedings until the plants are well established (10 inches tall for tall grasses and 6 inches tall for Kentucky Bluegrass).

Forage Species for Pastures or Hay

Grass Selection

Kentucky bluegrass is a shallow rooted, cool season perennial grass that has commonly been used for pasture for horses. Bluegrass is primarily productive during late spring/early summer and during the fall. It is less productive than other cool season grasses but is easy to establish and manage.

Tall fescue is a vigorous growing, sod forming, cool season grass that can withstand much animal trampling. It is suggested for paddocks and areas of surface abuse. This species will retain its leaves into cold weather and will extend the pasture season in Ohio into early spring and early winter. When this specie is used, plant only endophyte free seed to prevent the problems of decreased milk production, decreased growth, and possibly placenta abnormalities found with infected fescue.

Orchardgrass is an early, tall growing, high yielding perennial bunchgrass that makes more summer growth than the other grasses grown in Ohio. Orchardgrass must be heavily grazed or harvested as hay in May. It requires close management for maintenance as it can not stand trampling or continual close grazing.

Timothy is a late maturing and tall growing bunch grass that is not recommended for pastures because it can not take continual close grazing and produces only in late spring. It is more commonly used as a hay crop usually in conjunction with red clover or alfalfa.

Legume Selection

In general legumes are important in any pasture mix for the following reasons: (1) Nitrogen fixation - When 35% of the pasture plants are legumes, adequate nitrogen is supplied by the legume to maintain the production of the associated grass. This is an important economic factor when buying fertilizer. (2) Legumes contain about twice the protein level of grasses, thereby including them in a pasture mix will increase the nutrient value of the pasture. (3) Legumes enhance the acceptability, digestibility, and palatability of the pasture. This generally means better pasture utilization and healthier animals.

White Clover is a shallow rooted perennial that makes little growth during hot dry summer weather. Because it has a prostrate type of growth, it is well suited to permanent pastures and is usually included in pasture mixes. Ladino is a larger variety of the white clover and is recommended over the small white clover for horse pastures because of its greater production.

Red Clover is the most widely grown of the true clovers and is frequently included in pasture mixes for horses where tall fescue or orchardgrass is being seeded. Red clover is more tolerant of poorer drained soils, lower pH, and is easier to establish than many other legumes. However, it also needs to be reseeded more often than some legumes because it is a plant that basically lasts about two years.

Birdsfoot trefoil is a deep rooted, long lived pasture legume for Northern Ohio. The plant does not live long in Central and Southern Ohio and is not recommended for these areas. This plant is adapted to a wide range of soil conditions and will last for many years if properly managed. Special care is needed for seeding as the seedlings are weak and hard to establish. Only bluegrass should be planted with birdsfoot trefoil in pastures because of its sensitivity to grass competition for nutrients.

Alfalfa has the highest yield potential and the most feed value of all the perennial pasture forages. It is unexcelled in drought tolerance. However, it requires very precise seeding and grazing management because it requires excellent surface drainage, good internal soil drainage, and a pH of near 7.0. As a result alfalfa is not usually included in horse pastures, but used more for hay production.

Suggested forages and seeding formulas for horse pastures

Forage Species	Seeding Rate Pounds/acre
A. Kentucky bluegrass	2
and	
perennial ryegrass (used to help protect the other seedlings)	4
and	
ladino clover	1/2
(two pounds of timothy may be included in this pasture mix, but it adds little to total pasture production)	
B. Tall fescue (endophyte free, used for high traffic areas)	15
and	
Ladino clover	1/2
(For a cool season pasture mix add red clover seed to mix B at the rate of 8 lbs. per acre.)	
C. Orchardgrass (summer pasture) high management)	6
and	
Red clover	8
or	
Alfalfa	10
D. Birdsfoot trefoil (Northern Ohio only)	6
and	
Kentucky bluegrass	2-4
and	
Ladino white clover	1/2

Hay Quality

Hay quality is as important as hay quantity. With proper appraisial, hay can be selected that is both safe and worth the money paid for it.

The simplest method of evaluating hay is called the organoleptic (sensory) analysis, which includes the following:

Maturity — In general, the more mature the forage the less digestible it is and hence of lower nutritional value. This can be evaluated by looking at the coarseness and brittleness of the stems and the development of the seed head. If legumes are in full bloom or if grass seed heads are large, they are of lower feed value than plants cut at earlier stages of maturity.

Leafiness — The leaves contain most of the protein and nutrients that are highly digestible. Therefore, legume hays that are mostly stems or have a lot of shattered leaves are less valuable than leafy hays.

Condition — This can best be determined by smell and sight to detect mold and dust and by feel to determine brittleness and heat. All hay develops some heat after it is freshly baled, but if baled too green it will get very hot (over 100 degrees) and decrease the protein availability. Also if hay is baled too green, it is likely to mold or at best become dusty from damage done during the curing process.

Color — Green is ideal but over rated. Green is to be an indication of Vitamin A content and means that the hay had not been rained on prior to baling. Actually, rained on hay (unless it received a lot of rain over several days) is only slightly lower in nutritive value than hay that was not rained on. The loss in value is usually due to more leaf loss because of more handling to dry the hay for baling.

Foreign Material — Weeds and other trash in a hay sample would lower the value of the hay.

A simple score card for evaluating hay would assign the following values to these five characteristics of hay: Maturity - 30%, Leafiness - 30%, Condition - 20%, Color - 10%, Foreign Material - 10%.

In 1860, Henneberg and Stohman developed a laboratory method to chemically analyze feeds. The method, called Proximate Analysis, divided all feed into six fractions: Water, Ether extract, Crude protein (CP), Ash, Crude fiber, and Nitrogen free extract. The weakness of this analysis was that although it did analyze a feed for these six fractions, it did not determine how digestible the substances were in these fractions.

In recent years, the Van Soest Detergent Analysis was developed. This method uses the idea that the dry matter of all forage is either cell walls or cell contents.

Cell contents consist of sugars, starches, soluble carbohydrates, pectin, protein, non protein nitrogen, lipids, and water soluble minerals and vitamins. These contents are almost completely digestible (98%).

Cell walls consist of cellulose, hemicellulose, lignin, silica, keratin, waxes, cutin, insoluble minerals, lignified nitrogen compounds, and lignocellulose. In the horse the cellulose and hemicellulose are partially digestible thanks to the microbial digestion that takes place in the cecum and colon. The other cell contents are indigestible.

To process a hay sample, it is first dried and then mixed with a neutral detergent. This will produce two fractions; one is the cell contents and the second the cell walls (Neutral Detergent Fiber, NDF).

The NDF is then mixed with an acid detergent and two fractions are produced; one includes the parts that are digestible (acid detergent solubles) and the second is the indigestible portion (Acid Detergent Fiber, ADF).

The lower the ADF and NDF values the better the quality of the hay. High values indicate that hay has either been cut too mature or baled too green and damaged from excessive heat of fermentation during curing. Table 6-1 gives expected values for hays of different maturity.

Table 6-1. ADF, NDF, and CP Values of Hays of Different Maturity

Type of Hay	CP*	NDF	ADF
Alfalfa			
Late bud	>19	40	29
Early bloom	18	42	31
Mid bloom	15	46	35
Late bloom	12	50	37
Orchardgrass			
Late vegetative	14	55	33
Headed	9	65	45
Timothy			
Late vegetative	14	55	29
Headed	9	70	40

*Crude protein will vary about 2% on either side based on soil fertility and hay making procedures.

Today a chemical hay analysis will include ADF and NDF analysis, dry matter, and crude protein analysis. Thanks to the development of the Near Infrared Reflectance (NIR) method, hay samples can be quickly analyzed for quality. Forage samples for testing can be sent to the Research - Extension Analytical Laboratory (REAL). The local county extension agent has the information needed to send in a forage sample, and also the dates and locations for hay auctions in Ohio where hay is sold with this type of analysis available to the buyer.

Hay Harvesting

Hay should be harvested before it becomes too mature. Cutting in Ohio should be done as indicated in Table 6-2.

Table 6-2. Time to Cut Hay for Maximum Quality

Type of Hay	Date of first cutting*		
	South Ohio	Central Ohio	North Ohio
Alfalfa - orchardgrass	5/15-25	5/18-30	5/23-6/5
Alfalfa	5/20-6/7	5/23-6/10	5/28-6/15
Timothy - red clover	5/24-6/5	6/1-10	6/1-15

* Earlier cuttings make higher quality hay Subsequent cuttings can be made on alfalfa or alfalfa-orchardgrass every 35 40 days

Hay should be baled when moisture is less than 20 percent to prevent excessive heating (temperature in center of bale should not exceed 100 degrees F), which may cause molding or protein damage. In order to bale hay at higher moisture (not to exceed 30 percent), farmers have used organic acids such as propionic and acetic acid to prevent molding. They have also sprayed hay as they cut it to break down the waxes on the plant to hasten the evaporation rate of water from the cut plants. Sodium carbonate and potassium carbonate are two chemicals commonly used for this purpose. Hays cured using any of these chemicals to bale at higher moisture or to speed the drying time are safe for horses to eat.

Pasture Value

It is difficult to determine the value of pasture if you need to rent pasture as a feed source. Several formulas have been given, some of which are as follows:

1. Number of animal units (one unit = 1000 lbs.), times average price of 1 ton of hay, times a quality factor (quality factors are .22 = lush, .20 = excellent, .15 = fair to good, .12 = poor), equals rate per month.
2. Price of hay per ton divided by 8.5 equals rate per animal per month.
3. Seasonal rate should be 4 to 6 percent of the current market value of the pasture land.

Either of these formulas should give a reasonable rental value for pasture.

Part 7. Poisonous Plants and Substances

There are many poisonous plants that horses may eat. Fortunately, horses do not like the taste of most of the plants that are poisonous and will only eat them out of hunger or by accident when they are present in other feedstuffs. To help prevent poisoning your horse, observe the following rules: (1) Learn what plants are present in your pastures. (2) Destroy poisonous plants and keep fruit trees out of pastures. (3) Keep horses well fed on good quality, safe feeds. (4) Check hay and straw for poisonous plants. It is also wise to know the general symptoms of poisoning in horses. These are digestive disorders (colics, diarrhea, etc.), loss of appetite, nervous disorders (staggering, muscle twitching, listless or depressed), unusual bleeding, edema (fluid collecting under the skin for no apparentreason), sudden change of the vital signs (normal signs at rest are pulse = 32–50 beats per minute, respiration = 8–16 breathes per minute, rectal temperature = 100.4 degrees F).

Commonly Recognized Poisonous Plants

(Part 8. Plant Identification has drawings and identification information for some of the more common posionous weeds in Ohio.)

Laurel, Rhododendron and Azaleas

These are all poisonous but are not normally eaten by horses. If they are the only green plant available and horses are hungry, they may eat them.

Gymosperms (juniper, Ponderosa or western yellow pine, or Japanese yew)

Japanese yew is the worst of these because the horse likes the taste and will readily eat the plant. Yews are commonly planted around houses for decoration.

Solanaceous Plants (potato plants, tomato plants, nightshade, tobacco, eggplant)

These are poisonous but are not usually eaten by horses except in despiration for food.

Cyanide Plants (sorghums, Sudangrass, Johnsongrass, fruit trees)

These plants are readily eaten by the horse and every year some horses die as a result. Sudangrass is produced for livestock feed and can be fed to horses if it is at least 18 inches tall. It is the young tender shoots that are dangerous. It is recommended to cut sudangrass mechanically each day (to avoid molding) and bring it to the horse to eat. If sudangrass is pastured the horse will be eating the tender young poisonous shoots.

Fruit trees (apple, cherry, apricot, peach) can all be poisonous. The wilted leaves, bark and seeds are all dangerous. It will take a large quantity of apples to be dangerous, but horses have died from eating to many apples with seeds that contain the cynide factor. The wild cherry is the most dangerous of this family. It is very common to find in and along pasture fields in Ohio. The green or dried leaves are safe, but as little as a double hand full of wilted leaves or the bark can kill a horse. Therefore, it is wise to remove all wild cherry trees from pastures.

Poisonous substances

Walnut

Contact with the horse's body by the bark, hull of the nut, or the wood of waltnut will cause laminitis (founder) in the horse. The most common contact occurs from people using walnut shavings or sawdust as bedding. The shavings of walnut are

dark in color and would be most often found in shavings from furniture factories.

Monensin

This substance is commercially known as Coban or Rumensin. It is a feed supplement commonly used for cattle and poultry. Monesin is lethal in its pure form at the level of 1-2 mg/Kg of horse. Poultry feed with 100 g/ton or cattle feed premixes at 300 g/Ton are lethal to the horse.

Symptoms of poisoning are complete anorexia, profuse sweating, colic, stiffness, posterior paralysis, tachycardia, dyspnea, hyerpnea, and uneasiness. Sublethal doses cause poor performance, unthriftty appearance, and often heart failure.

Urea

Another substance used as a feed supplement for ruminant animals. Urea has little feed value to the horse, but the horse can tolerate feeds containing urea without death. However, if the horse would ingest pure urea, it would cause death.

Blister beetles

In recent years, a lot of publicity has been received by this beetle due to several deaths caused by horses ingesting them The blister beetle infests alfalfa fields that are in bloom. The beetles contain the irritant cantharidin and if the beetle gets baled into the hay and then is ingested by the horse, excessive irritation to the digestive tract and death can occur. This beetle is about one inch in length, pure black or black with grey edges on the wings, or black with a red head or grey with red bead, or yellow brown with dark stripes or grey. They have distinctive heads and long cylindrical bodies.

Blister beetles are not a likely problem in hay raised in Ohio, but if hay is purchased from the west and southwest, it should be inspected to be sure it is free of the beetle. If a hay field is harvested that is infested with the beetle, a conditioner should not be used as it kills the beetles in the hay. If the hay is only mowed the beetles can leave during the drying process. It would probably take more than 50 dead beetles to be lethal to a horse.

Part 8. Plant Identification

This section deals with the identification of plants that are commonly found in pastures and hay fields. The first part deals with the useful plants that we wish to grow and the second part deals with the weeds, some of which are poisonous.

Figure 1 represents the parts of a grass plant that may be used for identification.

Figure 2. Kentucky Bluegrass *(poa pratensis)* - A. has a narrow, v-shaped blade with boat shaped leaftip, B. rhizomes, and C. open panicle with small spikelets grouped in clusters.

Figure 3. Orchardgrass *(Dactylis flomerata)* - A. broad, v-shaped blade with very prominent midrib, sheath flattened, keeled, B. ligule is very tall and membranous, C. broad yellow collar, D.

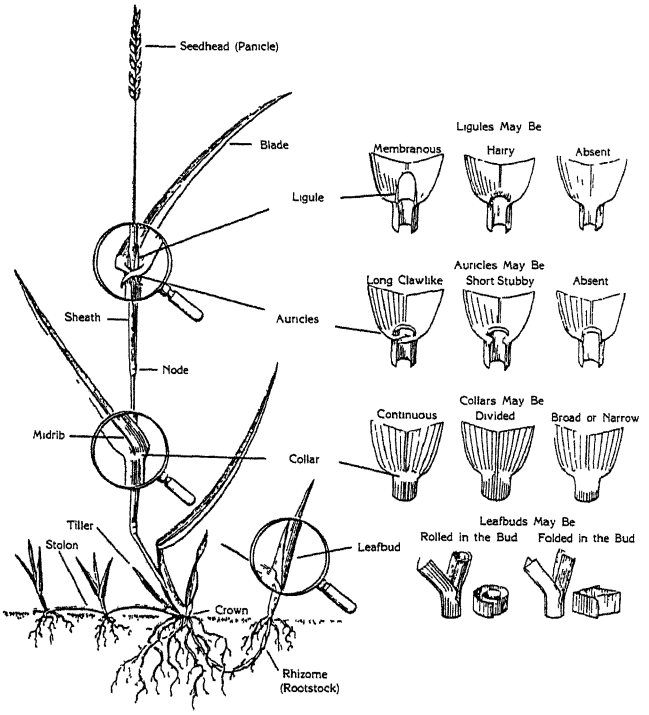


Figure 1: Parts of a grass plant

Figure 2: Kentucky bluegrass

panicle inflorescence with clumped spikelets.
Figure 4. Timothy *(Phleum pratense)* - A. broad flat smooth blade, B. panicle inflorescence as a dense cylinder, C. corms (bulb-like shape) found at base of stem.
Figure 5. Smooth Bromegrass *(Bromus inermis)* - A. wide, flat blade, sheath round (closed to near the top), B. large open panicle inflorescence, C. rhizomes, D. water mark on the blade (a M or W mark across the middle of the blade).
Figure 6. Tall Fescue *(Festuca arundinacea)* - A. rough, flat blade, with prominent veins and pointed tip, B. auricles are small, short, and hairy, C. short rhizomes and stems flat but not sharply keeled, D. open panicle with spikelets.

Figure 3: Orchardgrass

Figure 4: Timothy

Figure 5: Smooth bromegrass

Figure 6: Tall fescue

Figure 7. Identifies parts of the legume plants and shows a detailed picture of one leaf from each plant to be discussed.
Figure 8. Alfalfa *(Medicago sativa)* - A. pinnately (narrow) trifoliate leaf, B. outer 1/2 to 1/3 of leaflet is serrated, c. short, raceme type inflorescence with spiral-like seed pod.

Figure 9. Ladino clover *(Trifolium repens)* - A. palmately (broad) trifoliate with v)shaped watermark, B. weakly serrated leaflet, C. no trifoliate leaf from bloom to stolon, D. white with a pinkish hue to inflorescence. White clover is a smaller variety of the clover.

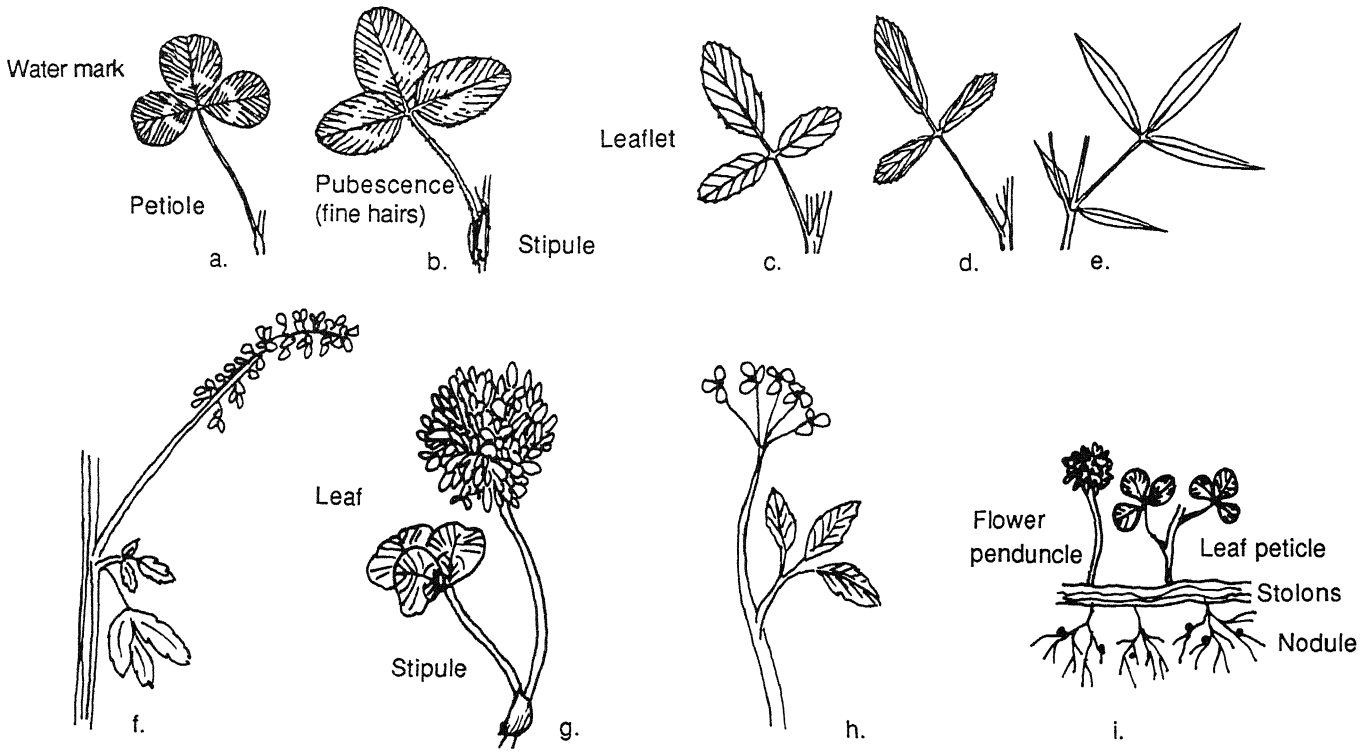


Figure 7: (a) White clover (b) Red clover (c) Sweetclover (d) Alfalfa (e) Birdsfoot trefoil (f) Raceme type inflorescene (g) Head type inflorescene (h) Umbel type inflorescene (i) Parts of white clover plant

Figure 8: Alfalfa

Figure 9: Ladino clover

Figure 10. Red clover *(Trifolium pratensen)* · A. palmately trifoliate leaf with football-shaped leaflets and v-shaped water-marks, B. sheath-like stipule, C. distinctly pubescent, D. has a trifoliate leaf just below a red inflorescence.
Figure 11. Birdsfoot Trefoil *(Lotus corniculatus)* · A. pinnately (5 leaflets) compound leaf, B. not pubescent, C. yellow to orange umbel inflorescence, D. seed pods resemble shape of bird's foot.
Figure 12. Yellow sweetclover *(Melilotus officinalis)* · A. pinnately trifoliate leaf, B. completely serrated leaflet, C. long and erect yellow raceme inflorescence, D. small stipules. There is also a white sweetclover *(Melilotus alba)* that looks the same except it has a white inflorescence.

Figure. 10: Red clover

Figure 11: Birds foot trefoil

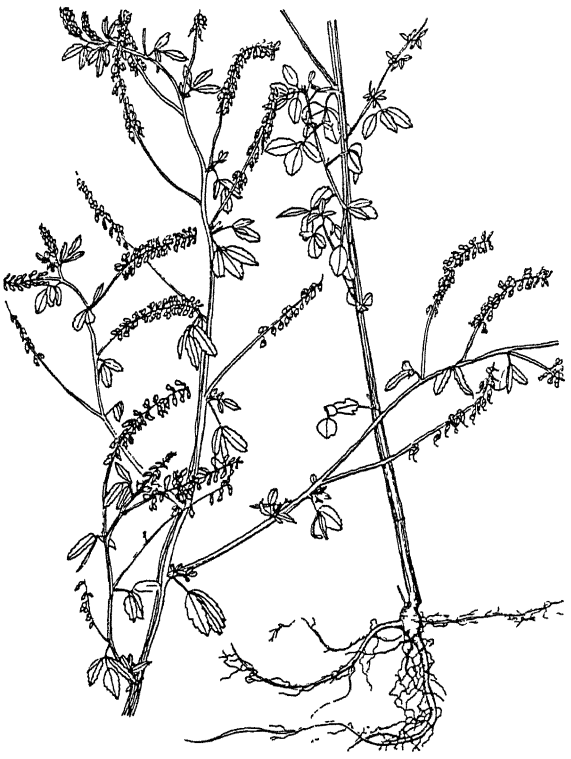


Figure 12: Yellow sweetclover

Weed Identification

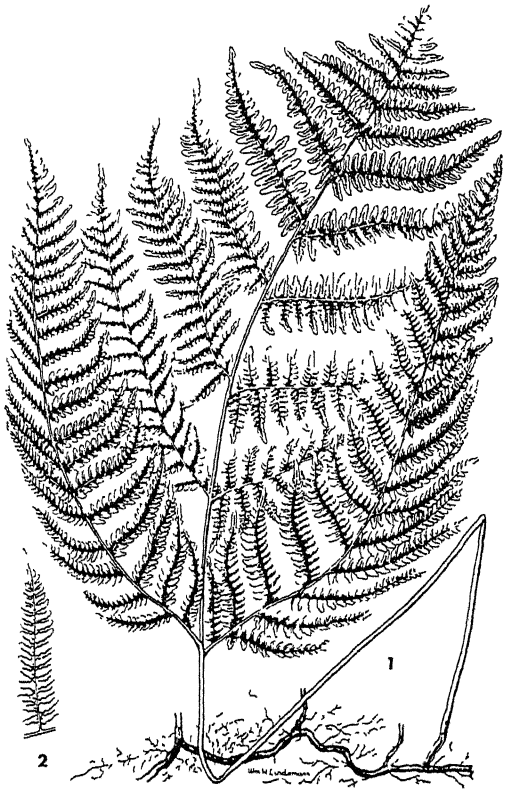
These are only some of the most common weeds found the pasture and hay fields of Ohio. For a complete list of weeds in Ohio, there is a publication called **Weeds of The North central States.** It is the North Central Regional Research Publication No 281 and is published by the University of Illinois at Urbana-Champaign, College of Agriculture, The Agricultural Experiment Station.

Braken Fern - Perennial plant growing 1 to 4 feet tall with leaves or fonds that arise directly from rhizomes and have many leaflets. Bracken Fern spreads by the rhizomes or by spores produced in a narrow brown band on the bottom of each leaflet. Found in woods, on hillsides, on acid soil, and in pastures. This is a **poisonous** plant if consumed over time but not usually eaten. Most often consumed in hay that had bracken growing in it.

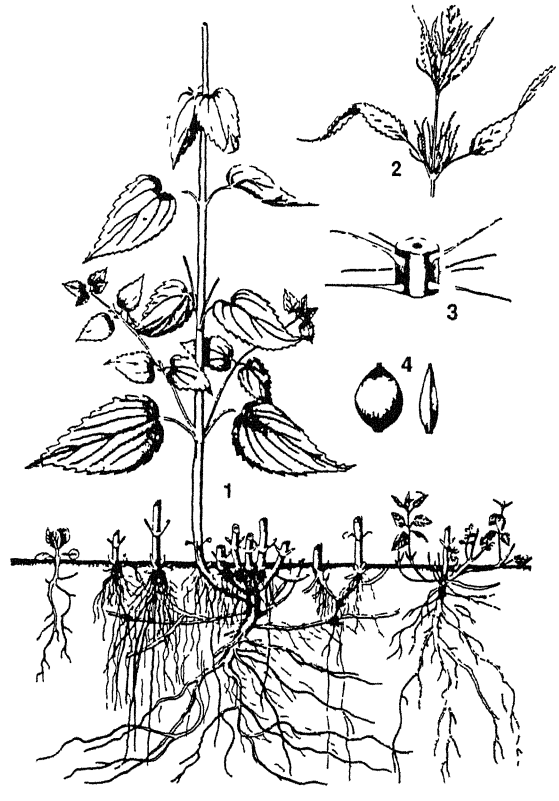
Foxtail - There are three varieties: green, yellow, and giant. Green and yellow grow 1 to 2 feet tall while giant and some varieties of green may reach 7 feet. The leaves of green are hairless while the other two have hair on the leaves. It is an **annual** plant reproducing from seed. The panicle is long and dense. Because of the bristles that are on the panicle, there have been cases where horses have had abscesses due to getting the bristles stuck in the skin.

Stinging Nettle - 1. Lower part of plant, 2. Upper part of plant with flowers, 3. Section of stem with hairs, 4. Seed. **Perennial** reproducing by seed and rootstocks. **Stems** are 2 to 7 feet tall, slightly branched near the top, slender, rigid, covered with numerous stinging hairs. **Leaves** are dark green, coarse, opposite, 3 to 6 inches long, pointed with saw-toothed margins, sometimes rounded at base, covered with stinging hairs. **Flowers** are greenish without petals and produced in clusters in the leaf axils. **Seeds** are small, egg shaped, slightly rough, yellow to grayish tan. Contact with the plant can cause inflammation and welts may form.

Foxtail



Bracken Fern



Stinging Nettle

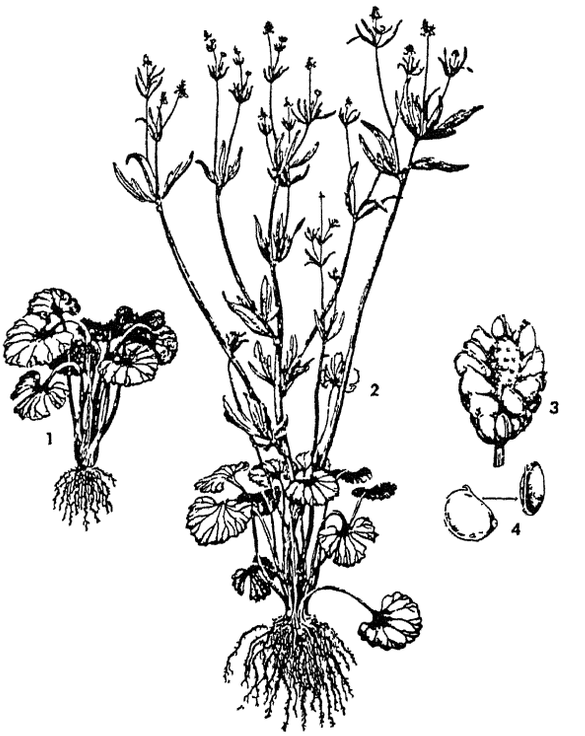
Curly Dock · 1. Lower part of plant, 2. Upper part of plant, 3. Seed. A **perennial** with large yellow somewhat branched taproot, reproducing by seed. **Stems** are smooth erect, 1 to 4 feet tall, single or in groups from the root crown. **Leaves** mostly basal, smooth 6 to 12 inches long, lanceolate, with wavy curled edges. Upper leaves alternate, the base of the short petiole having a papery sheath surrounding the stem. **Flowers** in dense clusters on branches at tip of stem, without petals, small, greenish, becoming reddish-brown at maturity. **Seeds** are brown triangular, and sharp edged, surrounded with heart-shaped bracts with smooth edges. There is also a Broadleaf Dock that is similar to curly dock except the leaves are broad and flat with a heart-shaped base.

Common Pokeweed · 1. Part of the fleshy root, 2. Branch with flower raceme and berries, 3. Flower, 4. Upper surface of berry, 5. Seed. **Perennial** from a very large poisonous taproot often 6 inches in diameter in older plants. **Stems** are stout and erect, 3 to 9 feet tall, smooth, branching above, often reddish, dying to the ground each winter. **Leaves** alternate, large but smaller toward top of plant, with short to long petioles. **Flowers** are small, white, in long, rather narrow, unbranched recemes from ends of stems and from upper branches. Fruit are a dark purple many seeded berry with red juice. **Seeds** are small flattened, round, and shiny black, about 1/8 inch in diameter. The root is the most **poisonous,** but leaves and berries can also be toxic.

Smallflower Buttercup · 1. Young plant, 2. Plant in bloom, 3. Mature receptacle bearing seeds, 4. Seeds. An **annual** or **biennial** reproducing by seeds. **Stems** slightly hairy, slender, branched from base, 6 to 20 inches tall. **Lower leaves** round, bright green with round toothed margins, borne on long petioles coming from base of plant. **Upper leaves** on shorter petioles, divided into 3 to 5 leaflets with somewhat toothed margins. **Flowers** small, yellow, with oblong petals **Seeds** produced in round heads, numerous, flattened with very small curved beak, dull, wrinkled, yellowish-brown. **Poisonous** to horses if green, safe if dried.

Common Pokeweed

Curly Dock



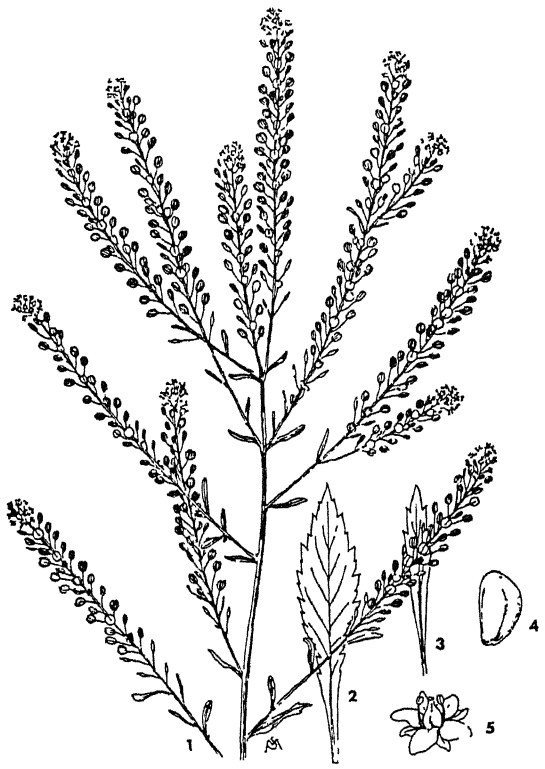
Small Flower Buttercup

Virgina Pepperweed - 1 Top of plant, 2. & 3. Leaves, 4. Seed, 5 Flower. **Annual** or **winter annual** reproducing from seed. **Stems** are much branched, 6 to 18 inches tall, not hairy, or with very fine hairs. **Leaves** on stem lanceolate to linear, coarsely toothed, usually without petioles; basal leaves obovate, with one large terminal lobe and several smaller dentate lateral ones, hairless. **Flowers** are small, white, 4-petaled, borne in racemes which grow for considerable periods, so that there are often ripe seeds below and flowers at the tip of the raceme. **Seed pod round, about 1/8 inch across, containing 2 reddish-yellow seeds.**

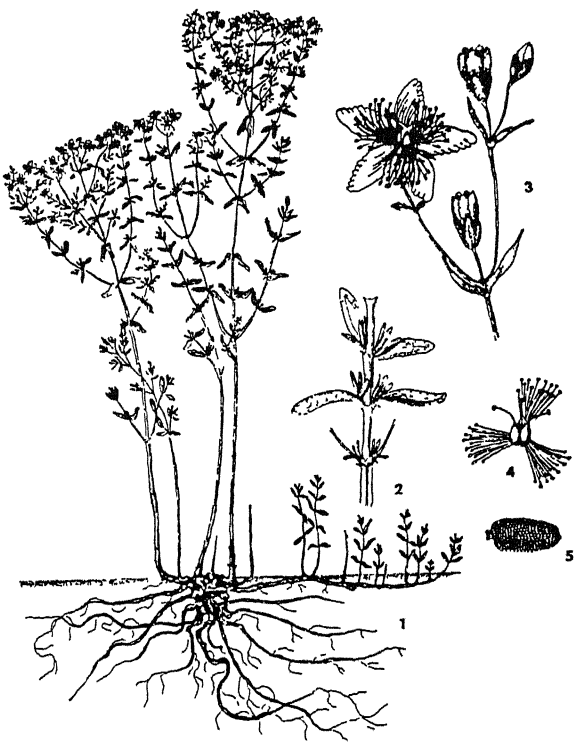
Poison Ivy - 1. Root and base of plant, 2. Flowering branch, 3. Cluster of berries and single berry, 4. Flower. Woody **perennial** which reproduces by seed or rootstocks. The plant my be a low shrub or vine climbing high into trees. In climbing it is supported by aerial roots along the stem. **Leaves** consist of 3 large shiny leaflets each 2 to 4 inches long, pointed at the tip. Leaflet edges either smooth or irregularly toothed. **Flowers** are small, green, 5-petaled, borne in a head 1 to 3 inches long. Berries are small, white, round, and hard. The plant changes from a bright green to a very attractive red or reddish-yellow in the fall. This plant can cause skin blisters.

St. Johnswort - 1. Plant in flower, 2. Portion of stem with leaves, 3. Flower and buds, 4. Stamens and ovaries, 5. Seed. **Perennial,** reproducing by seeds and rootstock. Root system branched and extending to considerable depth. Shallow, short rootstocks extend out several inches from crown. **Stems** smooth, branched, erect, somewhat 2-edged, 1 to 2 feet tall, woody at base. **Leaves** opposite, elliptic to oblong, covered with small clear dots. **Flowers** about 3/4 inch in diameter, 5-petaled, orange-yellow with occasional black dots along edges of petals. Seed pods rounded, pointed with 3 parts and many seeds. **Seeds** about 1/16 inch long, cylindrical, blackish, shiny with a rough pitted, resinous surface. **Poisonous** to horses but not usually eaten.

Poison Ivy



Virginia Pepperweed

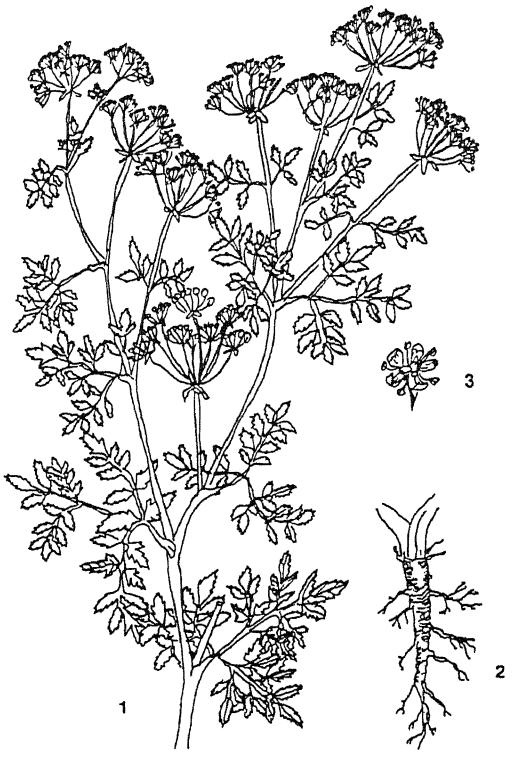


St. Johnswort

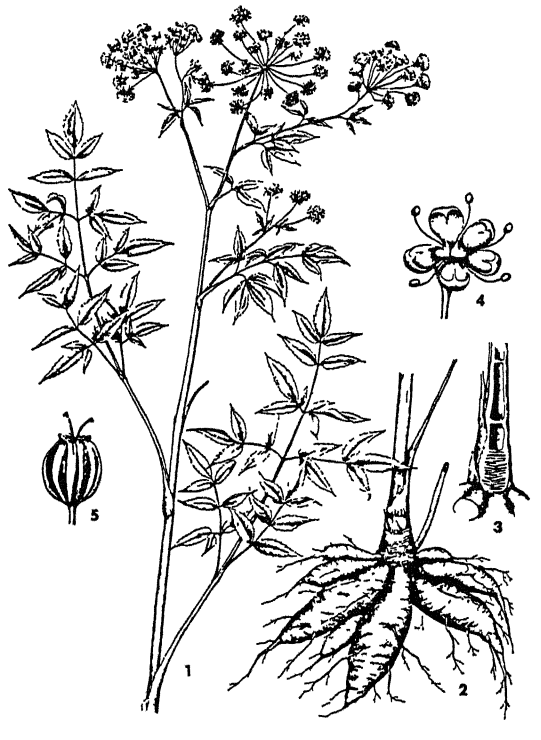
Spotted Water Hemlock - 1. Stems, leaves and flowers, 2. Roots, 3. Hollow base of stem, 4. Flower, 5. Seed. **Perennial** reproducing by seed or tuberous roots. **Stem** smooth, 3 to 5 feet tall, branched at top only, frequently streaked with purplish spots. **Leaves** are compound, 8 to 12 inches long, alternate, smooth with toothed edges, often spotted; base of petioles clasping stem. **Flowers** very small, with 5 white petals, borne in compound umbels. Seed flat on one side and rounded on the other, ridged lengthwise with light and dark lines. Found along waterways and seed and tubers have a distinct aromatic odor. All parts of this plant are **poisonous** and the roots are extremely poisonous.

Poison Hemlock - 1. Upper part of plant in bloom, 2. Root, 3. Flower. **Biennial,** forming a rosette the first year, reproducing by seed the second year. Root is fleshy, parsniplike taproot. **Leaves** are alternate, large, 4 to 5 times compound, finely divided, and toothed, giving a lacy appearance. **Stems** smooth, erect, 2 to 7 feet tall, much branched, with purplish spots and blotches; hollow between the nodes. **Flowers** white, produced in large terminal compound umbels that are flattish to slightly convex. **Seeds** are borne in pairs, ovoid, flattened, smooth, prominently ribbed, pale brown. Found along waterways and waste areas. The entire plant is very **poisonous.**

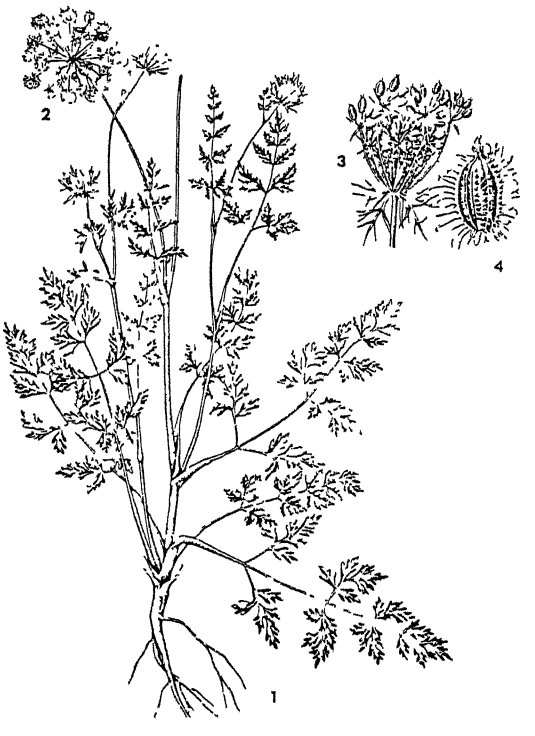
Wild Carrot (Queen Anne's Lace) - 1. Entire plant, 2. Flower head, 3. Head in seed, 4. Seed. **Biennial** that reproduces from seed. First year it produces rosette of finely divided leaves and fleshy taproot; in second year it blooms and dies. **Stem** (second year) erect, 1 to 3 feet tall, hairy , stout, and branched at top. **Leaves** are alternate, finely pinnately divided, hairy with distinct carrotlike odor. **Flowers** small, with 5 white petals, borne in umbels at ends of branches. **Seeds** 1/8 inch or less long, one side flattened, the other rounded and showing 4 heavy long-bristled ridges with smaller ones between. The outside seed bearing stalks curve in sharply as they mature.



Poison Hemlock



Spotted Water Hemlock

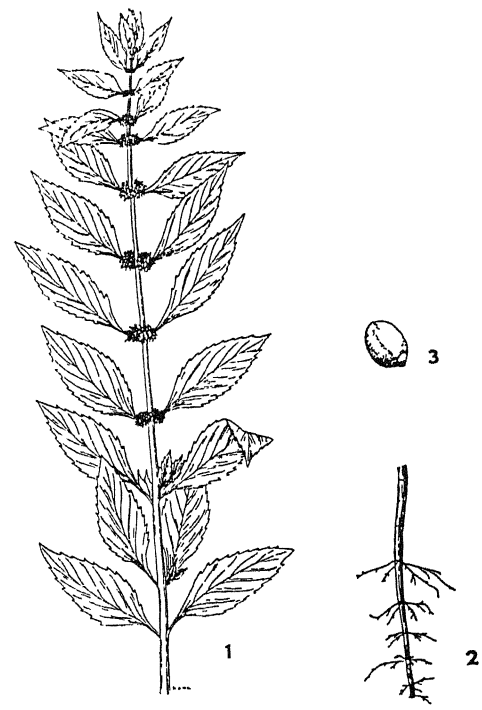


Wild Carrot

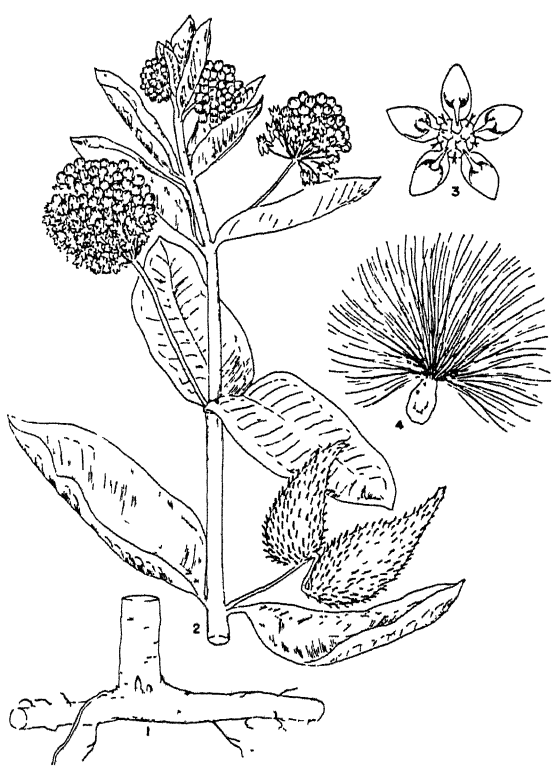
Common Milkweed - 1. Lower part of stem and rootstock, 2. Upper part of stem with flower clusters and seed pods, 3. Single flower, 4. Seed. **Perennial** that reproduces by seed and from rootstocks. **Stems** stout and erect, 2 to 5 feet tall, covered with short downy hairs, with milky juice. **Leaves** are opposite, oblong, rounded, 4 to 8 inches long with prominent veins. Upper surface smooth, lower surfaces covered with short white hairs. **Flowers** sweet-smelling, pink to white, in large, many-flowered, ball-like clusters at the tips of stems and in the axils of upper leaves. Seed pod is grayish, hairy, covered with soft spiny projections. **Seed** brown, flat, oval, with a tuft of silky, white hairs attached to tip. Most varieties of milkweed are **poisonous.**

Field Mint - 1. Upper part of plant, 2. Lower part of plant, 3. Seed. **Perennial** that reproduces by seeds and rhizomes, aromatic. **Stems** are square usually branching, up to 2 1/2 feet tall; barbed hairs on angles and sometimes on sides of stem. **Leaves** are opposite, with petioles, strongly scented, pinnately veined, narrow to oval, with small teeth on margins and with minute glandular hairs on leaf surface. **Flowers** are clustered in axils of upper leaves. Petals are pink, lavender, or occasionally white; 1/8 to 1/4 inch long, with 5 teeth and prominent nerves in the tube. **Fruits** are nutlets less that 1/16 inch long, smooth, light brown, each with and irregular dark line on the convex side.

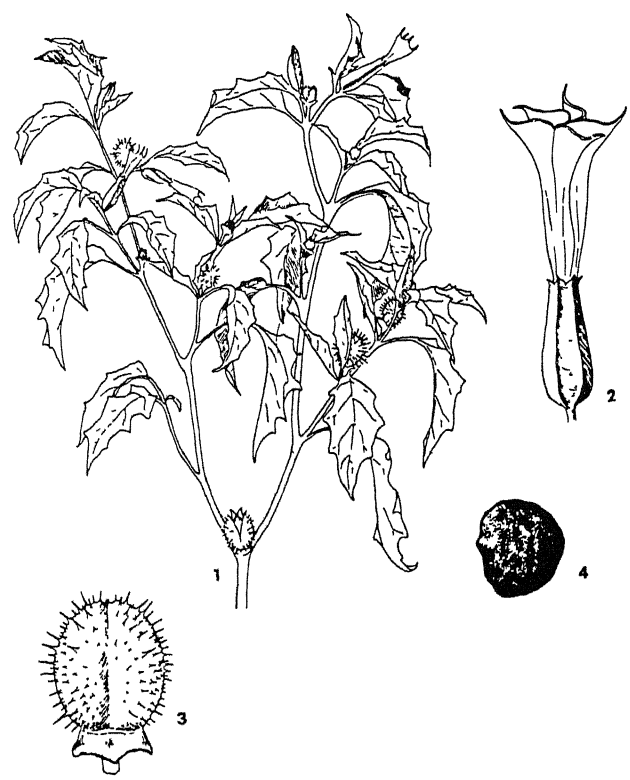
Jimsonweed - 1. Upper part of plant, 2. Flower, 3. Seed pod, 4. Seed. **Annual** that reproduces by seed. Roots thick, shallow, extensively branched. **Stems** smooth, thick, erect, branching widely in upper part, 2 to 4 feet tall. **Leaves** are alternate, large, coarse, smooth, ovate, with irregularly toothed edges and a distinctive rank odor. **Flowers** are large, funnel-shaped, white to pinkish, 2 to 5 inches long, borne singly on short stalks in the axils of the branches. Seed pod is about 1 inch in diameter, egg)shaped, covered with short, sharp spines. **Seed** is dark brown to black, kidney-shaped, flattened, surface irregular and pitted. The entire plant is **poisonous** to livestock.



Field Mint



Common Milkweed



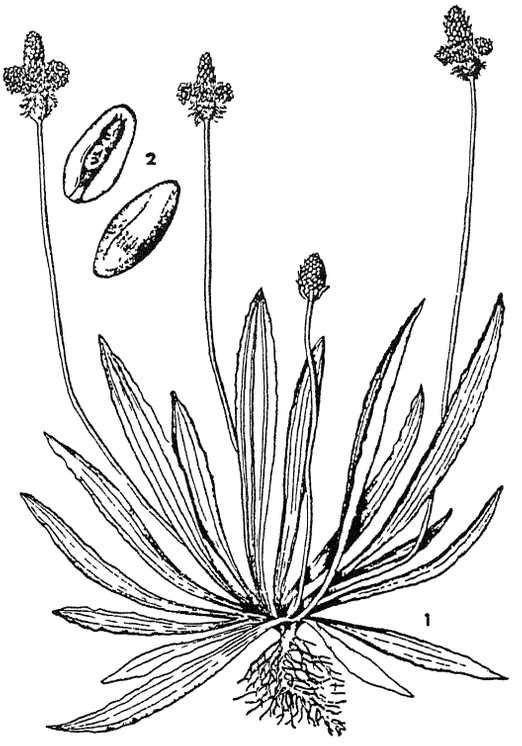
Jimson Weed

Bitter Nightshade - 1. Fruiting branch, 2. Cluster of flowers. **Perennial** that reproduces by seeds and by rooting of prostrate stems. **Stems** are slender, vinelike, somewhat **woody,** 2 to 10 feet long, twining on low vegetation or prostrate on the ground. Leaves are dark green, 2 to 5 inches long, variously lobed at based, alternate, petioled, with a disagreeable odor. **Flower** is purplish or white, 5-lobed, about 1/2 inch across, in loose clusters from the axils of the leaves. Berries are oval, about 3/8 inch long, light green turning bright red ate maturity, containing many seeds. **Seeds** are about 1/16 inch in diameter, round, flattened, light yellow. This is a mildly poisonous plant found along fence rows. Should not be confused with bittersweet which has orange fruits, is woody and more viny in growth. There is also an Eastern Black Nightshade that is similar and is also poisonous that has green berries that turn black, leaves are not lobed at the base, and has an erect stem, 1 to 2 feet tall.

Buckhorn Plantain - 1. Entire plant, 2. Two views of seed. A **perennial,** reproducing by seed. **Stems** are erect, leafless, 4 to 12 inches long, terminating with flower spike. **Leaves** are at ground level in a basal rosette, hairy, 2 to 10 inches long, 1/4 to 1 inch wide, with 3 to 5 prominent veins running lengthwise.

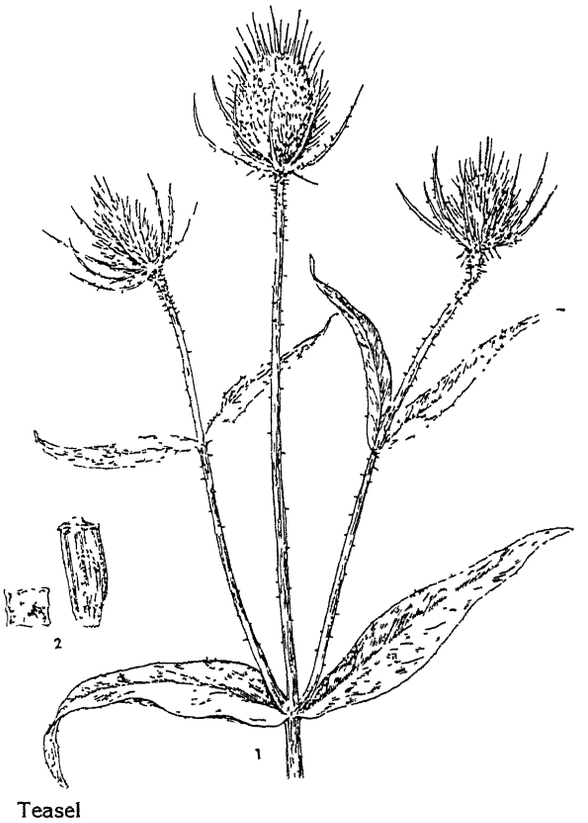
Flowers numerous, petals inconspicuous, in short cylindrical spikes at ends of stems. Seed pods are 2-seeded, splitting across the middle. **Seeds** are small, brown, shiny, smooth, boat-shaped, with an indentation in the middle of one side, sticky when damp. There is also a Broadleaf Plantain that has broad, egg-shaped leaves with petioles and the seed pods are in a cylindrical pattern on the upper several inches of the stem.

Teasel - 1. Portion of stem with flowers, 2. Seed. Biennial plant reproducing from seed. **Stem** the second year is coarse, upright, prickly, 2 to 5 feet tall. **Leaves** are lance-oblong, toothed, prickly on margin; a rosette the first year, opposite the second year. **Flowers** are lilac or white, with 4 petals, in dense ovoid heads with numerous slender bracts that become stiff*hooked prickles at maturity. **Seeds** are about 3/16 inch long, 4-angled, ridged, hairy, grayish-brown.



Buckhorn Plantain

Bitter Nightshade

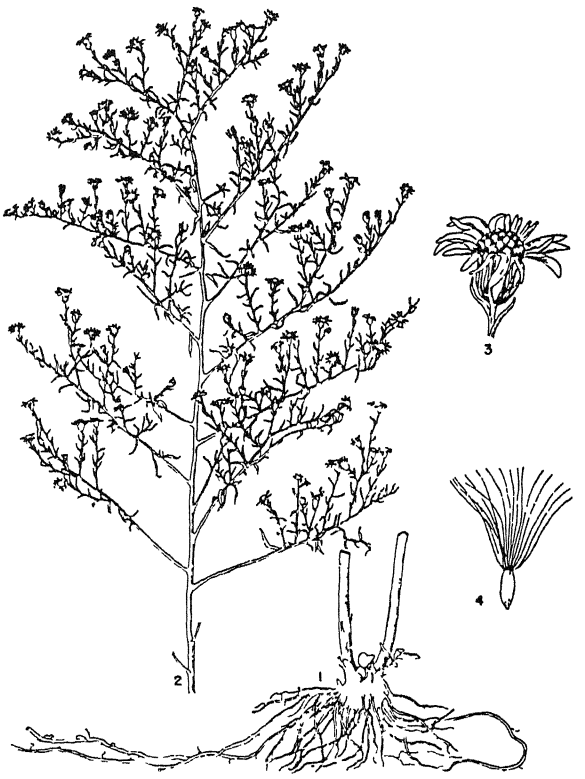


Teasel

Common Ragweed - 1. Plant, 2. Seed. An **annual** shallow rooted plant. **Stems** are rough, hairy, erect, **branched,** 1 to 4 feet tall. **Leaves** nearly smooth, deeply cut into a number of lobes, mostly alternate. **Flowers** of two kinds; male pollen-producing flowers in small inverted clusters at tips of branches; seed-producing flowers fewer, borne at the bases of leaves and in forks of upper branches. **Seed** is about 1/8 inch long, enclosed in woody hull, light brown, top-shaped, pointed, bearing several longitudinal ridges ending in short, spiny projections. There is also a Giant Ragweed that grows 12 to 18 feet tall with broader leaves that have 3 to 5 lobes.

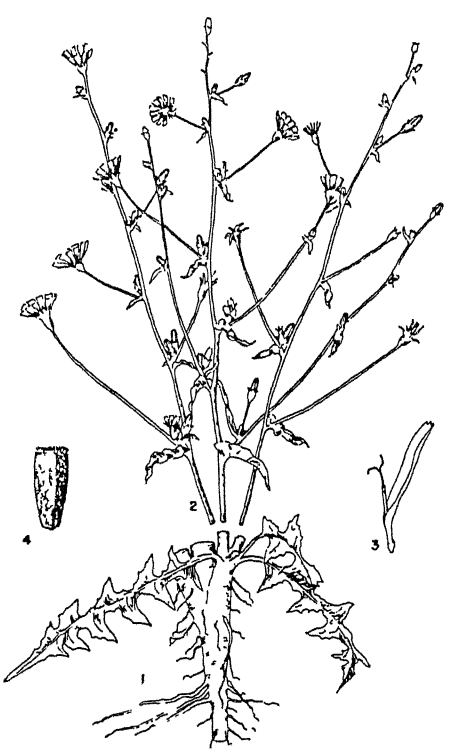
White Heath Aster - 1. Basal part of plant, 2. Flowering part of plant, 3. Flower head, 4. Seed with down attached. A **perennial** with fibrous roots developing from the hard enlarged crown. **Stems** are erect, 1 to 4 feet tall, hard and tough, smooth or usually hairy or stiff-hairy, upper two-thirds much branched. **Leaves** are at base narrowly lance-shaped, those on upper stem become very small and narrow, sharp-pointed, numerous. **Flower** heads are 1/2 to 3/4 inch in diameter, very numerous, mostly on upper sides of branches, white ray flowers surrounding the yellow disk flowers. **Seeds** are small, oblong, light brown, with a tuft of silky hairs attached to the top.

Chicory - 1. Root and crown, 2. Upper portion of stems with flowers, 3. Individual flower, 4. Seed. A **perennial,** reproducing by seed. Taproot large, deep, and fleshy. **Stem** is erect, branched, smooth, and with a milky sap. **Leaves** are basal and along the stems. Basal leaves form a rosette, 6 to 8 inches long, lobed, and resembling those of a dandelion. Leaves on stems are smaller and either less lobed or entire. **Flower** head of ray flowers only, bright blue,, about 1 inch across, formed at ends of branches and in the axils of leaves of upper part of plant. Flowers are most conspicuous in the morning and close late in the day. **Seeds** are dark brown, wedge-shaped, about 1/8 inch long.



Whate Heath Aster

Common Ragweed

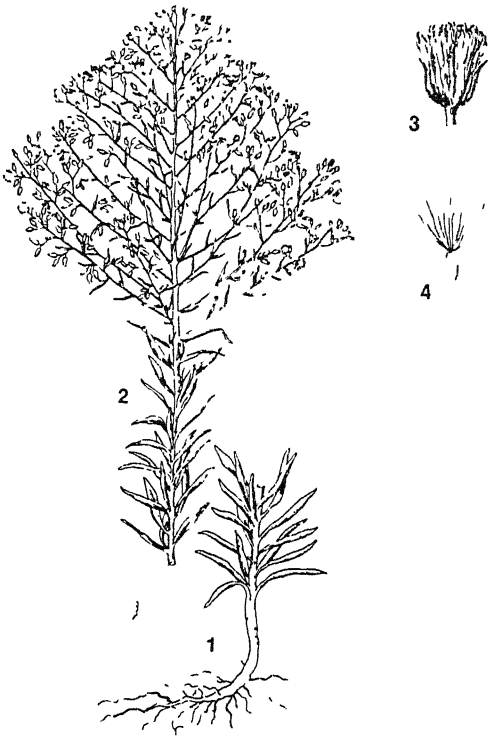


Chicory

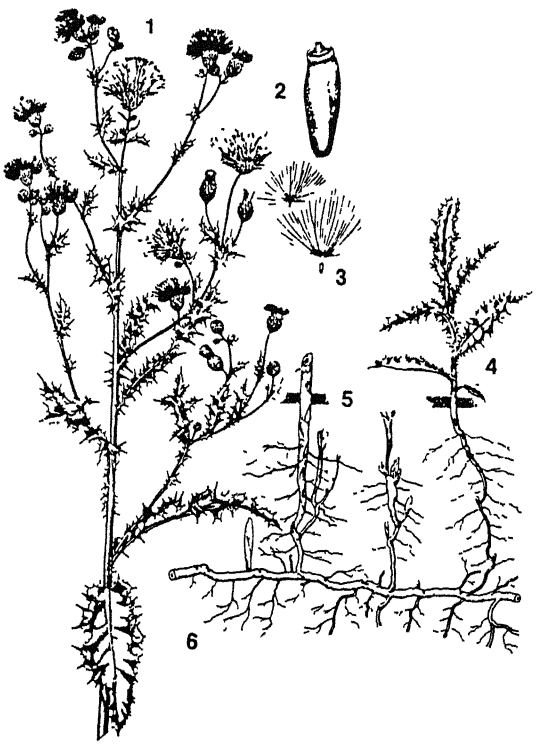
Canada Thistle - 1. Upper part of plant, 2. Seed, 3. Down with Seed, 4. New shoot, 5. Base of stem, 6. Root system. A **perennial** reproducing from seeds and horizontal roots. Roots extend several feet deep and some distance horizontally. **Stems** 2 to 5 feet tall, grooved, branching only at the top, slightly hairy when young, increasingly hairy as they mature. **Leaves** usually with crinkled edges and spiny margins, somewhat lobed, and smooth. Flower heads numerous, compact, about 3/4 inch or less in diameter, of lavender disk flowers only. Surrounded by bracts without spiny tips. Male and female flowers usually in separate heads and borne on different plants. **Seed** is brown, smooth-coated, slightly tapered, about 3/16 inch long and with a ridge around the blossom end. Seed is attached to tannish down that is easily broken off. There is also a Bull Thistle that is very similar except it is a biennial, reproduces only from seed, have a larger bloom, and the seed is straw colored, striped with brown.

Horse Weed - 1. Lower part of leafy stem, 2. Upper part of stem with flowers, 3. Mature flower head, 4. Seed. An **annual** that reproduces by seed. **Stem** is stout, erect, unbranched at base, 1 to 6 feet tall, with bristly hairs. **Leaves** are numerous, without petioles, linear, dark green, with scattered coarse white bristles, margins toothed or entire. **Flower** heads numerous, small, in axillary panicles, a narrow-pointed bract at the base of each head. Ray flowers greenish-white, scarcely noticeable, surrounding yellow disk flowers. **Seeds** are about 1/16 inch long with numerous slender white bristles on one end.

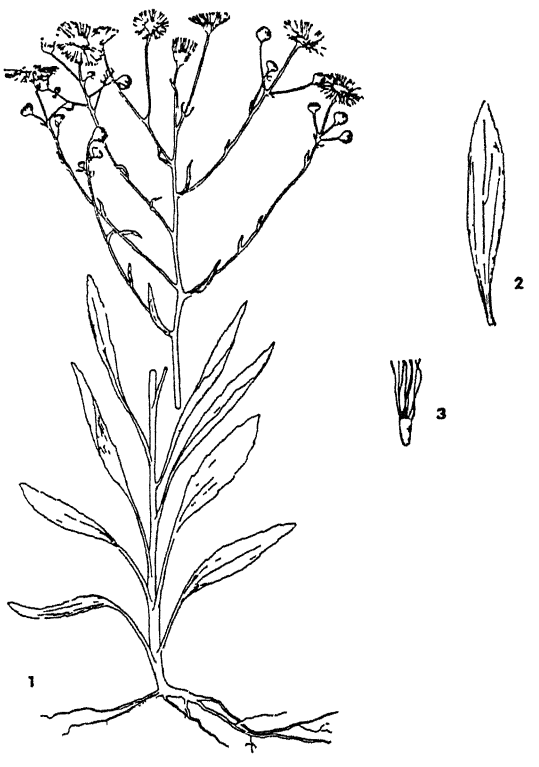
Rough Fleabane - 1. Plant, 2. Leaf from middle of stem, 3. Seed. **Annual, winter annual, or biennial,** reproducing from seeds. **Stems** are clustered, 1 to 3 feet tall, hairy, with numerous branches from the upper part. **Leaves** variable, lower ones ovate, upper lanceolate, blade often tapering toward base to form more or less winged petiole. **Flower** heads 1/2 to 1 inch in diameter, white to lavender ray flowers surrounding the yellow disk flowers. **Seeds** are 1/16 inch long, wedge-shaped, with a tuft of short white bristles at top.



Horseweed



Canada Thistle

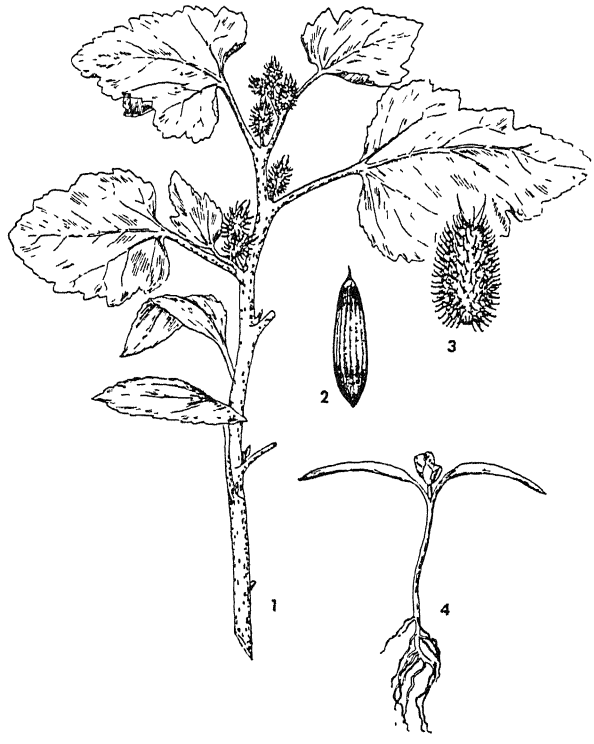


Rough Fleabane

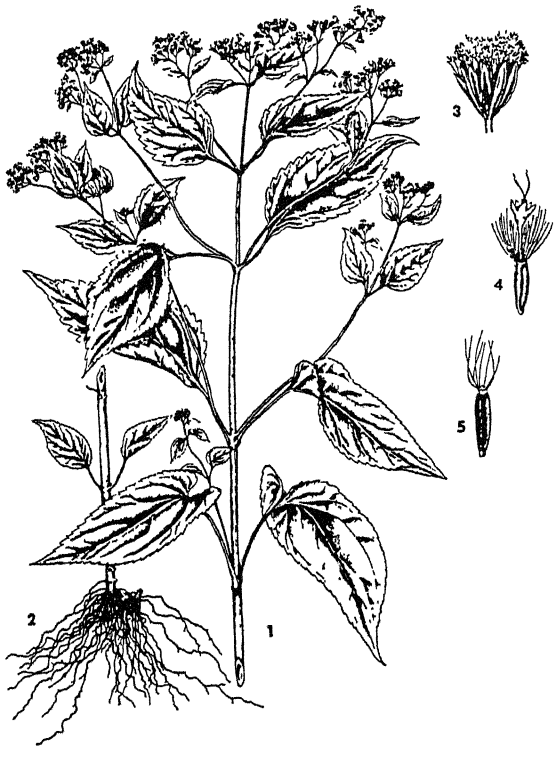
White Snakeroot - 1. upper part of plant; 2. root; 3. flower head; 4. single flower; 5. seed. A **perennial,** spreading by seeds and short rhizomes. Roots are much branched and fibrous. **Stem** is 1 to 3 feet tall, smooth, and branched near the top. **Leaves** are opposite, elliptical, thin, smooth, with toothed edges and slender petioles. **Flower** heads are small, of white disk flowers only. **Seed** is black, angular, about 1/8 inch long, with a tuft of white hairs. More common is wooded pastures. It is **poisonous** to livestock.

Common Cocklebur - 1. Upper part of plant, 2. Seed, 3. Burr, 4. seedling plant. An annual, reproducing by seed. Taproot rather woody and stout. **Stem** is erect, normally bushy, 2 to 4 feet tall, ridged, rough-hairy, often spotted. **Leaves** alternate, simple, triangular in outline, toothed or lobed, rough, with petioles. **Flowers** are small, male and female flowers separate but borne together in clusters in axils of the upper leaves. Two female flowers are enclosed in each oval burr. At maturity the burr is hard, woody, and covered with hooked prickles, and ends in 2 curved spines. Male flowers numerous, in clusters on short stalks, dropping soon after pollen is shed. **Seeds** are about 1/2 inch long, dark brown, rather slender with pointed tips. Leaves and stems are **poisonous,** but rarely eaten because of bitter taste.

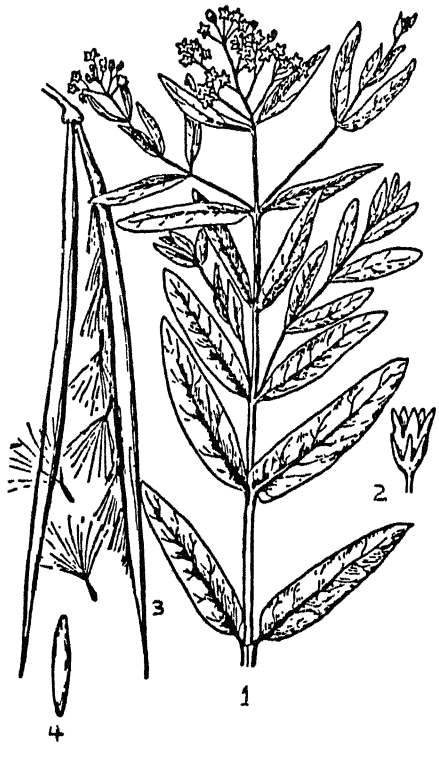
Indian Hemp - 1. Flowering shoot, 2. Flower, 3. Pod, 4. Seed. **Perennial** from creeping root stock or seeds. **Stems** erect, branched, with fibrous bark and milky juice, 1 1/2 to 8 feet tall. **Leaves** opposite, simple, short petioled, oblong-ovate, and glabrous. **Flowers** in terminal, rather dense, in clusters, mostly erect, greenish-white 1/8 to 3/16 inches long. **Fruit** two long slender follicles, smooth, less than 5/16 inches in diameter, with numerous linear seeds with apical tufts of hair. The plant is **poisonous** green or in a dried state.



Common Cocklebur

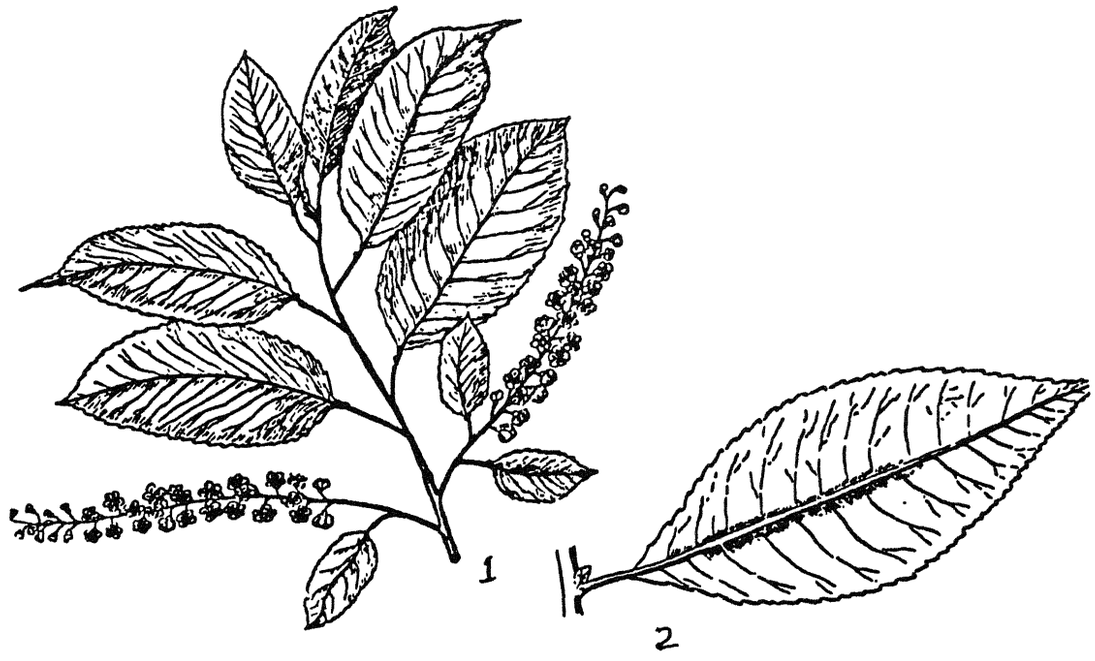


White Snakeroot



Indian Hemp

Wild Cherry - 1. Branch with buds, 2. Leaf. A tree. **Leaves** are alternate, simple, lanceolate to oblong 2 to 4 inches long, finely serrated with slender or blunt incurved teeth, with glands along the petiole. **Flowers** are white in racemes or umbel-like clusters, rarely solitary, with 5 petals, numerous stamens, 1 pistil. **Fruit** dark purple or black with one seed. Wilted leaves or the bark are very **poisonous.**



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